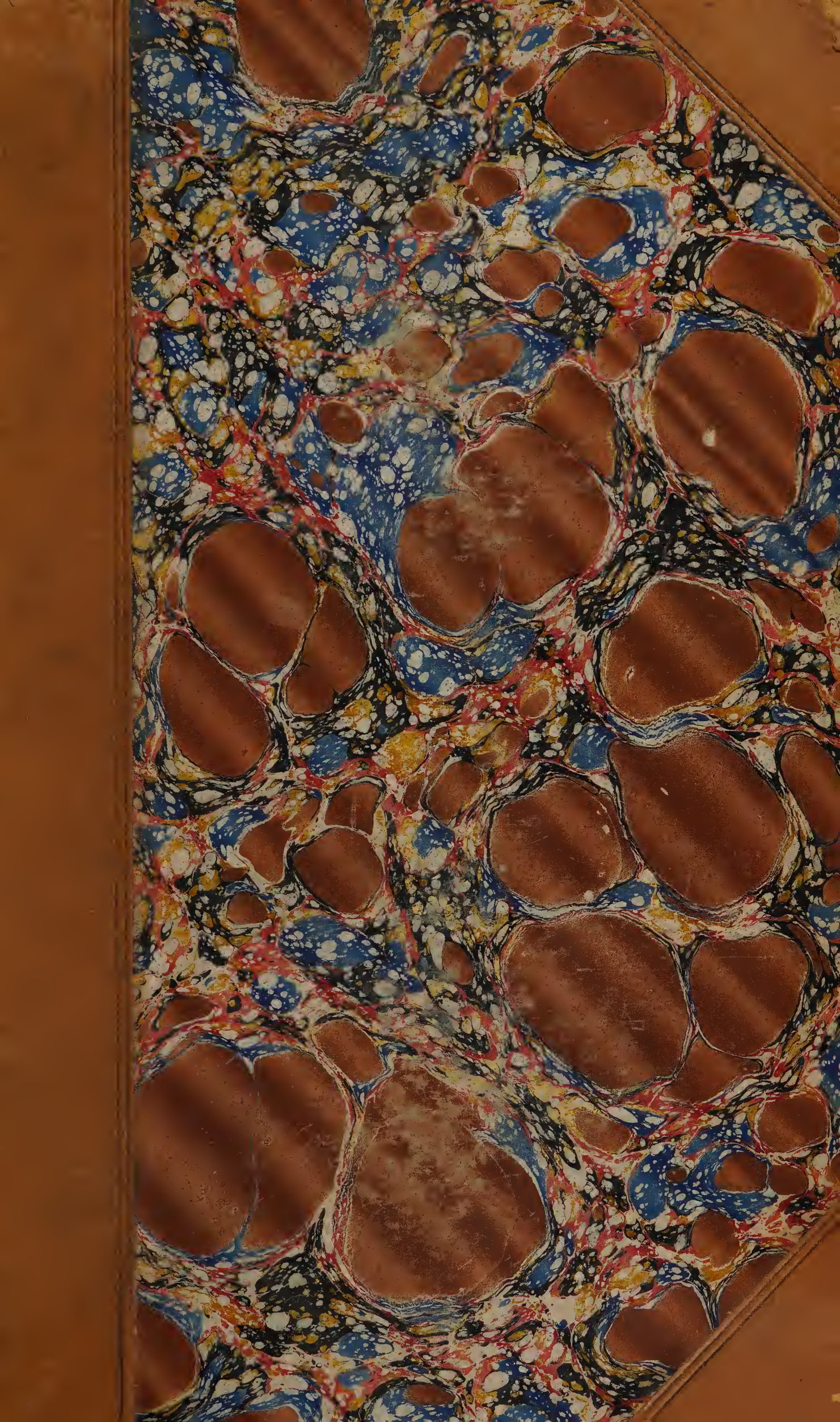

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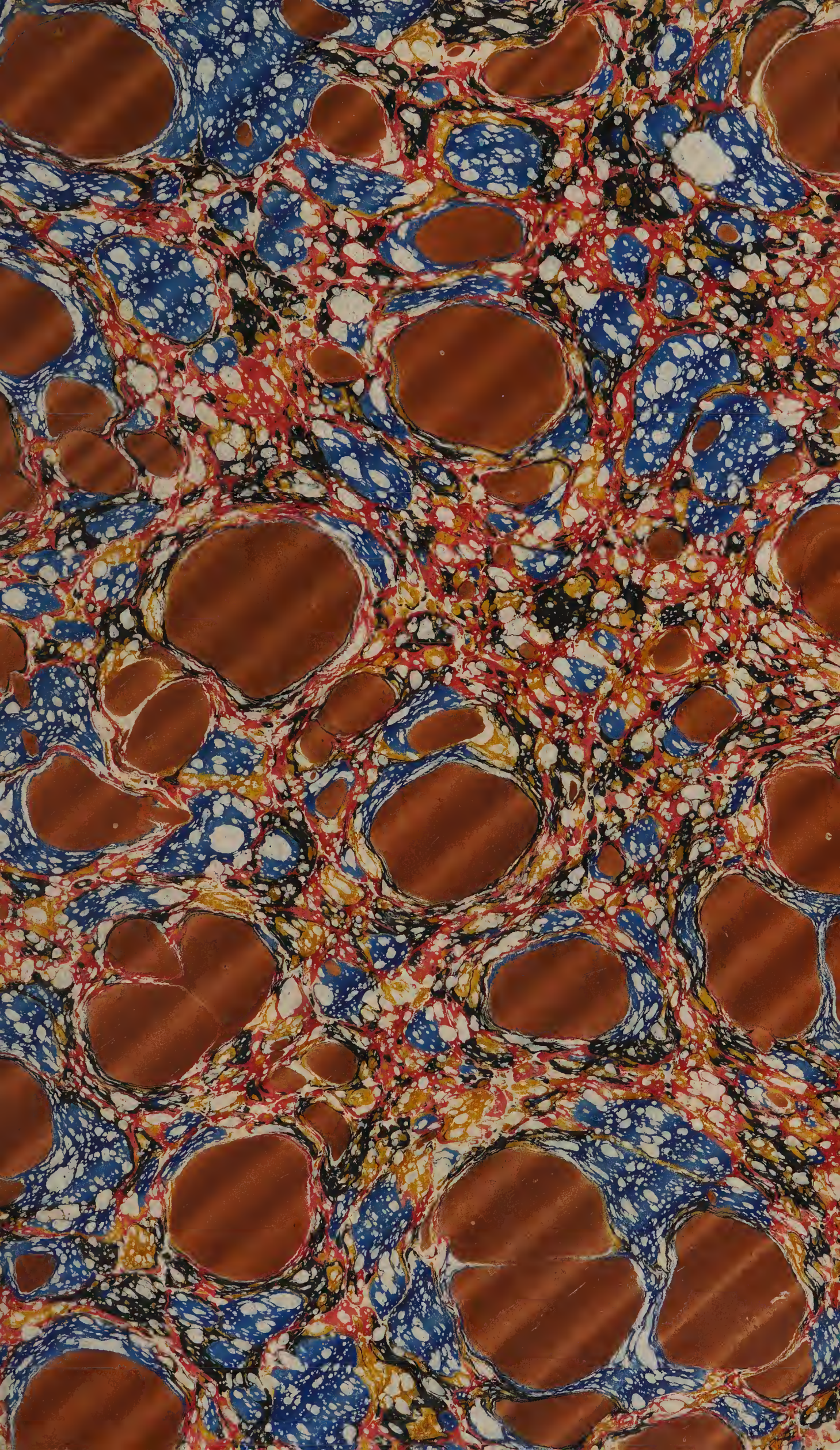

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THE

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AND

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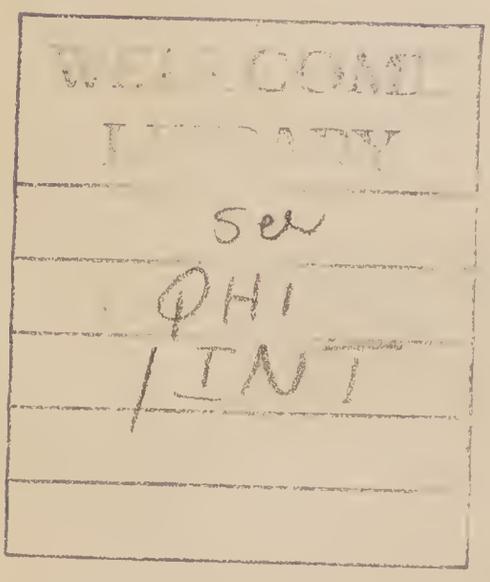
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BRITISH BEETLES AND THEIR FOREIGN REPRESENTATIVES.

1. Cicindela campestris.
2. Cicindela Chinensis.
3. Otiorynchus ligustici.
4. Lachyrynchus gemmatus.
5. Lachyrynchus speciosus.
6. Lachyrynchus reticulatus.
7. Lapholus Schönherri.
8. Carabus intricatus.
9. Carabus Hispanus.

THE INTELLECTUAL OBSERVER.

FEBRUARY, 1863.

ENGLISH BEETLES AND THEIR RELATIVES IN THE TROPICS.

BY H. NOEL HUMPHREYS.

(*With a Coloured Plate.*)

During the winter months, when the more generally attractive classes of insects are but rarely met with, the entomologist may still seek with success for several kinds of beetles, which may be found under large loose stones, or beneath flakes of dead bark, or in the shelter of matted clumps of moss. Sport, however, is not so abundant, nor the weather for pursuing it so pleasant as in summer; insomuch, that the collector is sometimes forced upon the study of dried specimens in cabinets, rather than the living specimens in their native haunts. In this way I have been driven from the open fields to the task of comparing, in various collections, some of our best known British beetles with specimens of their exotic relatives; speculating on the possible influences of climate, or immediately surrounding conditions, on their development and general aspect. I have found the occupation both instructive and amusing, as are all studies connected with entomology. No form of animal life has in fact attracted the attention of naturalists more constantly, and proved more generally instructive, than that of insects. Among these the beetle tribe especially were noticed by the ancients at a very early period, from two very opposite points of view—superstition and philosophy. With the sacerdotal naturalists of Egypt, who had carefully observed the habits and transformations of the beetle, that insect became a symbol of the principle of metempsychosis, and other theological dogmas; while with the Greeks, in the hands of Aristotle, it became an example of one of the acutest methods of classification, founded on anatomical structure, that science ever devised. Finding that the whole of the beetle family were furnished with wings protected by a sheath-like covering, he compounded of the word χολεος, a scabbard or case, and

πτερον, a wing—a term which, latinized as Coleoptera, is still applied to the entomological order comprising the beetles. It is true that some of the insects included by Aristotle in his great family of Coleoptera, have been removed by modern science to other natural orders; but the great distinctive feature, as a class definition, and also the very name by which the father of natural history distinguished it, are both retained in the natural philosophy of modern times, no better character or name having been found for the order of insects to which they were originally applied by the Macedonian entomologist of two-and-twenty centuries ago. More than one among our modern naturalists have sought to alter the venerable term invented by the founder of their science, but none of their suggestions have been permanently adopted. It is indeed well that they have not, for although embodying some advantages, we should have been the losers by the change of that fine aroma of antiquity that hangs about the venerable term invented by the Stagyrite. Fabricius suggested the term *Eleutherata*, and Clairville endeavoured to establish his own title, *Elytroptera*, for the beetle tribe, either of which terms might have served their purpose with great propriety; but the good old name, Coleoptera, was destined to hold its ground, and it is now too well established to fear erasure by any modern pen, however innovative or daring.

Speaking of Aristotle reminds me of a curious error of the press which occurs in M. Guerin de Menneville's preface to the *Revue Zoologique*, in which, speaking of the vast range of the works of Cuvier, he calls him, "cet *Arioste* des temps moderne."* The passage thus becoming one calculated to astonish, not a little, the great French naturalist, who certainly never expected, even accidentally, to be compared to the author of the *Orlando Furioso*.

Our native beetles are not so conspicuous by their forms, or so finely coloured as those which attracted the attention of Aristotle in the fine climate of Greece, but there are yet many among them that are not without considerable beauty; and indeed our native species of Cicindelidæ are not surpassed by their near relatives in the more southern parts of Europe, and are scarcely inferior in beauty to some of their intertropical relatives with which I am about to compare them. The commonest, and at the same time the prettiest of the British species of Cicindela, is the well known *C. campestris* (No. 6), the elegant and active little green beetle, with yellowish spots, that may be found in sandy districts on any fine sunny day of early spring. This species has long been known to collectors as the tiger beetle; as some say from its spots and stripes, but as

* Meaning of course *Aristote*, the abbreviated form of the name of Aristotle commonly used by the French.

others assert from its carnivorous nature, preying as it does upon other insects, and occasionally even upon its own species. These beetles were also termed by our old collectors, "sparklers," from their brilliant aspect when the sun shines on them, especially during the short but rapid flight which they indulge in during sunshine, especially when alarmed, making a humming noise like bees. M. Desmarets was the first to observe the method pursued by the larvæ of tiger beetles for capturing their prey. They construct, as he informs us, a narrow tunnel or pit of the depth of about eight or ten inches in perpendicular depth, sometimes more than a foot, according to the nature of the earth in which it is formed, which is generally sand. When complete, they climb to the mouth of the tunnel, making their broad flat head, which they cover with sand, form a kind of trap-door to this treacherous oubliette. They sustain themselves in the desired position by means of two hook-like appendages, plainly shown in the annexed representation of this ingenious and predatory larva, till a small insect passes over the living trap-door concealed by a treacherous layer of sand, when the larva immediately allows itself to drop to the bottom of the burrow, followed of course by the tumbling victim, who is speedily devoured. If the insect passing over the trap is too large to fall readily into the tunnel, it is seized as it passes, and dragged forcibly down to its destruction in the dark pitfall. These treacherous Cicindelæ are in truth very garotters among the insect races—insect ticket-of-leave-men of the very worst class. Nothing is known of the larvæ of exotic Cicindelæ, but Labreille considers that in all probability they resemble, both in form and habits, those of the European species. The female of *Cicindela campestris* may be distinguished from the male by the presence of two additional buff spots. *C. Germanica* is another British species, and also *C. hybrida*, of which last there is a specimen in the collection of the Linnean Society, with the name in the handwriting of Linnæus himself.

Larva of *Cicindela campestris.*

In the climates of the New World many Cicindelæ are found in the vast forests. Some of these appear not to be predatory, but live on the bark of trees, while others reside among the foliage, flying rapidly from leaf to leaf, and darting with great dexterity upon their prey. In 1839 it was calculated by Baron Dejean that 250 species of Cicindelidæ were known, the greater number of the species being exotic or extra European. The exotic species generally resemble our own, in being commonly of a green bronzed colour, elegantly variegated with streaks and spots of white, buff, orange, or red on the elytra or wing-sheaths, but

there are many variations from this general character. *Cicindela lepida,* found in the Deccan, is black, with an orange mark on the back like a saddle; and *C. flavi punctata,* also found in the East Indies, is of a deep blue, nearly black, with four orange spots. M. Chevrolat describes several Mexican species, among which *C. curvata* burrows in moist sand, when the sun is obscured, or the wind cold. The natives macerate this species in water or spirits to procure a liquor possessing medicinal qualities, which are highly valued. The pretty *C.* 6-*punctata* and *C.* 20-*punctata* are described by Westerman as being found on young rice plants in the West Indies, and these, notwithstanding the great difference of climate and surrounding circumstances, do not very much differ from our native species, either in size or the general tone of the colouring; while in Cochin China, where the temperature is moderate, and much nearer to our own, a marked difference occurs in the long-legged species, very distinct in character, which has been separated from the genus Cicindelæ by Laporte, under the generic name Odontocheila. In Calcutta a species is common which materially differs in habits from all the previously-described species, which love the brightest daylight, and seek some retreat as soon as a cloud obscures the sun, while the species alluded to flies by night only, being attracted by a lamp, like moths, and entering rooms when candles are lighted, and even the cabins of ships at anchor in the Hoogly.

The larger of the Cicindelæ belong to the genus *Manticora,* among which there are species near two inches long, chiefly found on the arid plains of Africa. These are entirely black, and differ essentially from our kinds in having no available wings, the elytra, or external wing-cases, being joined down the middle of the back, instead of being divided in the usual manner. Some of the exotic species have available wings without using them; and M. Lacordaire says that *Megacephala sepulchralis,* a South American species, is one of this kind, never flying, but running from danger with great swiftness through the long rank grass in sandy places in the Brazils. This species, like the English *C. campestris,* emits a pleasant, rose-like odour. Another Brazilian species often takes possession of the deserted burrows of the Copredæ, the entrance of which it defends with great pertinacity, but feeling itself overpowered, it retreats to the bottom and will not appear again. Its pugnacious disposition, however, renders its capture easy. The collector has only to insert a long straw to the bottom of the burrow, when it will immediately be seized by the insect, and refusing to let go its hold, may thus be drawn out and captured. Among all the exotic Cicindelidæ, whether belonging to temperate or intertropical climates, none mate-

rially surpass in elegance of form or colour our own *C. campestris,* except the exquisitely beautiful Chinese species, *C. Chinensis,* one of the most common insects of the tea-growing districts, and which is often found in the chests of tea exported to this country. It may be observed, as a curious fact, that, while none of the tropical species materially surpass our own either in form or colour, this remarkably handsome insect, inhabiting a climate very similar in general temperature to our own, so far surpasses both in size and beauty our pretty *Cicindela campestris.* Exquisitely clouded markings of deep purple, rich in tone and texture as tinted velvet, form the most conspicuous feature in the colouring of this insect; these masses of purple shading off at the edges into the rich apple green which forms the general ground; the green becoming in places nearly a silvery azure. This green ground is again varied by conspicuous marks of delicate buff; the central ridges of the elytra being also of a buff tone, with a metallic gloss of gold. The richness, and at the same time intricate delicacy of this colouring is such as cannot be perfectly imitated in a drawing, yet the representation in the plate (No. 7) will serve to give a fair general idea of the beauty of this finest of the exotic Cicindelidæ.

The next class of English beetles that I found the means of comparing with their exotic relatives, was a section of the extensive order Curculionidæ. None of the native species of these pretty little beetles—with their long neck and head, of almost trunk-like form, which gives them the air of miniature elephants, and in consequence of which they have been named *κυρκυλιω* (neck or throat)—are remarkable either for size or colour. Most of the tribe are herbivorous, and among the best known of the British species is the corn weevil, *Calandra granaria,* which feeds on grain. Then there is the well-known *Balaninus nucum,* the larva of which is found in ripe nuts, and by means of which the forms of the larvæ of all the kinds may be approximately known. The perfect insect drills a hole with its long trunk in the young nut, and the larva when full grown eats a hole through the hard shell after it has devoured the kernel. Falling to the ground, it buries itself to undergo its transformation, which is completed in the following spring. The Curculionidæ have not the gift of speed like the Cicindelæ, but, when danger approaches, fall from the spray on which they are feeding, and remain perfectly still, with the legs collapsed, as though dead. Those of the genus Otiorhynchus, like several others, feed on growing roots, while the species of Scolytus and others feed on the young wood of forest trees, beneath the bark.

Though exceedingly numerous, our native species are all

small and inconspicuous, while the exotic genera of the tribe contain many of the most splendid insects yet known, among which may be cited, as a well-known example, the celebrated Diamond beetle of Brazil. The English Curculio, which I have taken as being a fair general representative of our native kinds, is *Otiorhynchus ligustri*, the common Curculio of the Privet, represented at No. 1. This insect, of a dull olive brown colour, with the tuberculations of the elytra rather paler, has certainly no pretensions to beauty except, perhaps, in the general elegance of its form. But directly we approach the tropics for the purpose of examining his foreign relatives, we find not only that many of the species assume a very superior growth, more than quadrupling the size of our native kinds, but that their splendour of colour often equals, if it does not surpass that of any other class in the whole insect world.

The most remarkable contrast among exotic species, both in size and beauty, to our native Curculios, occurs perhaps in the magnificent *Eupholus Schönherri*, discovered in the Island of Cœlebes, by the officers of "La Coquille," the French ship of discovery that circumnavigated the world in 1833. It was first taken at a little seaport of Cœlebes, called Dory, one of the hottest parts of that intertropical region, and which, in the general account of the voyage, is described as swarming with resplendent insects of various kinds. The first specimen of this till then unknown relative of the Curculios, which was captured on that occasion, and which eventually found its way to the collection of M. Chevrolat, was seen and described by M. Guerin for the zoological section of the voyage of "La Coquille," when he made it the type of a new genus, which he called *Eupholus*, a term adopted by Boisduval when he described other allied species discovered in the voyage of the "Astrolabe." The name appears to be composed of the Greek words, ευ, fair, and φολις, a scale, in allusion to the powdery bloom similar to the minute scales of the wings of butterflies, with which its elytræ are covered. The representation in the plate (No. 5) can give but a faint idea of this subdued metallic kind of lustrous bloom, but the general distribution of colour is well represented. M. Guerin describes the ground colour as being of a lovely glaucous green, slightly metallic, the corslet being brilliant azure, passing off imperceptibly to a delicate green at the edges; the wing-cases having transverse stripes of deep velvety black, and the space comprised between the first and second pair of stripes, and between the third and fourth, being a fine light blue. The specimen in the British Museum, recently sent from Cœlebes by our enterprising collector, Mr. Wallis, does not entirely agree in colour with M. Guerin's description. This may be accounted for by the colours having changed or faded

in dead specimens, or from the specimen in M. Chevrolat's collection, or the one in the Museum, being a variety. The colours of the large specimen in the British Museum, and also of several smaller specimens, are as follows :—The head, ochreous green, with deep brown stripe; the corslet, a brilliant lilac, becoming pink in high light, and changing to green towards the edges; the elytræ are of a bluer lilac, and have five transverse bars of black, the spaces between the first and second bar and the third and fourth being a greenish white, which contrasts very delicately with the blue lilac of the other portions of the wing-cases; the legs are brilliant metallic green, with the exception of the joints, which are of a rich purplish azure and very brilliant; the antennæ are of a delicate cinereous green, with brown tips. I believe the largest specimen in the Museum is marked as a variety; but as there are several specimens exactly like it, except in size, our specimens may prove to be distinct species.

Several other species of the new genus Eupholus have been discovered since *E. Schönherii;* some at the same port, Dory, and other parts of New Guinea; one in the Island of Amboyna, and one or more in the Arrow Isles, during the subsequent voyages of discovery of the "Astrolabe" and the "Zelee." M. Guerin describes in detail the six additional species of his new genus Eupholus in the *Revue Zoologique,* for 1841, all magnificent insects, with green and blue elytra, finely striped with black bands; but they are all of inferior size and beauty to the original type of the genus, which in its turn is inferior to the variety or new species in the British Museum (No. 5 in the plate).

Another section of exotic Curculionidæ, the species of which form a striking contrast with our native kinds, on account of their great brilliancy, is principally founded on the beautiful insects of this class from the Philippine Islands, which were procured by Mr. Cuming a few years ago, all of them till then unknown to European naturalists. For the classification of these insects, M. Germar first established the genus *Pachyrhynchus,* formed of the Greek word παχος, thick, and ρυγχος, a beak or bill, from the thick elongation of the head, as distinct in character from that of the European *Otiorhynchus.* The new name was first given to a single species which was at that time commonly received from Manilla, being the only species then known. MM. Eydoux and Souleyet met with and described another species from the same place in 1839. But these were nothing to the wonderful collection of this glittering Curculian group brought to Europe by Mr. Cuming in 1840. Mr. Cuming, an English merchant, was residing at Lima, and trading from thence to the Philippines, when he became greatly

interested in the formation of a collection of marine shells, for which the shores of those islands have long been celebrated. Sailors whom he engaged as his agents to purchase specimens from the natives, brought back a few insects as well as shells, and these were of a character to make our collector turn his attention in that direction, leading eventually to the discovery of those brilliant specimens which so much astonished the entomological world of the year 1840 with their novelty and splendour. On his arrival in Europe Mr. Cuming disposed of some of his new Philippine insects to M. Paryudhaki, and these were described by M. Chevrolat, in 1841, in the *Revue Zoologique* for that year; while M. Guerin, in 1842, described a species from a new locality, the Salomon isles, making the fourteenth of this new and magnificent genus. Other species followed, which were described by M. Guerin, all, with the one exception above named, belonging to the Philippines.

Those purchased of Mr. Cuming by the trustees of the British Museum were described by Mr. Waterhouse, bringing up the number of species to near fifty, and it is from among those last that I have made the selection represented in the plate, namely, *P. gemmatus* (2), *P. speciosus* (3), *P. reticulatus* (4). Of these *P. gemmatus* is by far the largest and most splendid. But its splendours are of that minute as well as metallic character which cannot be exhibited in a drawing unless greatly magnified, and even then the glitter of the metallic effects would remain unrepresented. The ground colour is a rich crimson maroon, with a golden gloss in the high lights. But the large spots, which have the appearance of being inlaid with a variety of gems, form the chief feature. In the centre of each of these gemmed circlets the inlaid colours appear to be composed of minute triangles of turquoise and emeralds, with granules of silver between, while towards the margin the emerald disappears, and the mixture is blue and yellow, with a larger admixture of the granules of silver, the whole surface being so brilliantly polished that each minute gem is distinctly seen. It is, however, only in the microscope that all the magnificence of the details can be fully appreciated, though sufficiently splendid even to the unassisted eye. The pretty *P. reticulatus* and *P. speciosus*, Nos. 3 and 4, are also beautiful insects, from the excessive clearness of their markings, and the high polish of their entire surface, but they fall far short of the splendour of our *gemmatus*, or even of the *P. gemmans* of the French collection.

Our native *Carabidæ* are another class which I compared with their foreign relatives. It is in this division that some of the largest and most robust of the beetle tribe are found, and I made many comparisons bearing on the influence of climate,

etc. I have however, at present, only space to allude to the British and Continental specimens figured in the plate, Nos. 8 and 9. The native species, *Carabus intricatus,* which has received its specific name from the intricacy of the tuberculations by which the surface of the elytræ are variegated, was so rare a very few years ago that some considered it not truly indigenous; but it has since been captured in some numbers, in consequence of the discovery that moths were attracted by melted sugar brushed on the bark of trees at night, which happened to prove equally attractive to our night-roaming beetle, *Carabus intricatus,* and numbers were taken by the newly discovered bait. The "golden beetle," *Carabus auratus,* belongs to the same genus, and is perhaps the handsomest of the native *Carabi.* This species, like many of the *Carabi,* is carnivorous, and is called by the French *Le Jardinier,* as the enemy of cockchafers. It attacks the female when in the act of depositing her eggs, and so destroys at once a whole brood of those destructive insects. The *Carabidæ,* which are *carnivorous,* thus feed on other beetles which are *herbaceous* feeders, just as carnivorous quadrupeds prey upon those that are herbivorous. The golden beetle is a very handsome insect, but with all his brilliancy he is not comparable to his foreign cousin, *Carabus Hispanus.* This last species is not indebted to a tropical sun for his superior brilliancy; for, on the contrary, his habitat is on the borders of eternal snow, in the Alpine regions of Central Europe. The true genus *Carabus* in fact disappears on approaching the tropics, as it does also in more northern latitudes, while the allied genus *Calosoma* is distributed all over Europe and even South Wales; and on some future occasion I may endeavour to trace the change of aspect of this widely distributed insect in different climates. On the present occasion I have only space to refer very briefly to *Carabus Hispanus,* as a contrast to our native *Carabi.* In the first place he is nearly twice the size; but the size is his least attraction. It is in his brilliant metallic colours that his great beauty chiefly consists. The head and corslet are of the richest metallic purple, while the elytræ, or wing-cases, are of the most dazzling olive gold, so solidly brilliant that chased and burnished metal itself could not surpass it. In the lights this golden glitter becomes a yellow, while in the shades it assumes a ruddy tone, getting richly crimson in a narrow channel round the edges. *Carabus aurofasciata* is another splendid exotic species—from India; not, however, from the tropical plains, but from the mountainous regions of the north. It is of a deep bronze tone of colour, with a broad diagonal cross of light brilliant gold colour on the back, extending across both the elytræ.

It will have been observed that a widely distributed family of insects do not invariably assume strikingly different aspects by the influence of climate. It will also have been seen that it is not always beneath the sun of the tropics that increased size and increased brilliancy of colour are found. The differences of aspect, indeed, in so far as we can estimate them by reference to climate, appear very capricious. It may, however, be assumed as the more general rule, that the most splendid and gigantic insects of intertropical regions present characteristics very distinct from those of insects belonging to the temperate zones, and therefore, in most cases, comparison cannot be made with reference to changes brought about by influence of climate; each region appearing to have a strongly marked insect family peculiarly its own, no members of which (with a certain allowance for exceptions) appear in their really characteristic forms beyond the limits of certain geographical lines.

OBJECTS ILLUSTRATIVE OF ROMAN PROFESSIONS AND TRADES, DISCOVERED IN THE EXCAVATIONS AT WROXETER.

BY THOMAS WRIGHT, F.S.A.

In a former paper in the Intellectual Observer I gave an account of the discoveries made, during the autumn of 1861, in excavations in a field which occupied part of the site of the cemetery of the Roman city of Uriconium, at Wroxeter, near Shrewsbury. Since that time, a field adjoining, which occupies a portion of the same cemetery, has been the scene of excavations, and, although but partially examined, it has been no less productive than the other in interesting discoveries. Among the objects brought to light on this occasion are a rather considerable number of sepulchral urns and other vessels in earthenware and glass, with various objects of a more miscellaneous character, among which one of the most remarkable is a Roman surgeon's lancet, an article I believe to be unique in Roman antiquities, certainly among those found in Britain. The discovery of such an instrument, under these circumstances, rather naturally draws our attention to the more general subject of the professions and trades practised in the towns of Britain during the Roman period—a subject of the more importance because they were probably the origin of the professions and trades of our mediæval period, and through them, in some measure, of those of modern times. What were the

trades and professions exercised in the great Roman city of Uriconium, and under what form were they carried on?

It is evident that in the circumstances generally attending the Roman remains found in our island, discoveries such as I have just alluded to must be extremely rare, and it is only in the almost undisturbed ruins of a great city, like Uriconium, that we can hope to meet with anything which is authentic to our purpose, that is, which belongs to professional or industrial occupations exercised on the spot. We meet with abundance of manufactured articles, but there are no circumstances connected with them to enable us to say where, or by whom, they were manufactured. Although the buildings which we have been chiefly exploring within the ancient town of Uriconium were of a public character, and not likely to yield us much information of this sort, yet enough has been found, even in the very small space yet excavated, to show that we may hope, as we proceed further, to make discoveries which will throw great light on this subject, and, indeed, on the whole internal economy of a great Roman town in Britain, in the beginning of the fifth century. Meanwhile it will, perhaps, not be uninteresting if I give here a brief and collective account of the objects already discovered, which belong to professions or industrial callings exercised in ancient Uriconium. And first let us speak of the lancet just mentioned.

We seem to know but little of the surgical practice, or of the use of the lancet, among the Romans, but we learn from Celsus that the name by which this instrument was known was *scalpellus*, or, sometimes, *scalper* and *scalprum*, words which mean simply a small cutting instrument; while, at a rather later period, Isidore of Seville gives it its Greek name *phlebotomum* (*φλεβότομον*), which expresses its more especial use in letting blood by making an incision in the vein. The *scalpellus*, or lancet, represented in the cut annexed, was found in the recent excavations in the cemetery of Uriconium, and had, no doubt, been deposited in the grave of the surgeon who had used it; but it is uncertain whether it was placed in his sepulchral urn with his ashes, or beside it, for the latter was broken, and its contents scattered about before they were noticed by the workman. Along with the lancet were found a small lock and some beads, with other remains, from which it appeared that these, and probably the lancet also, had been inclosed in a box or casket, no doubt of wood, which, of course, had perished, but it had been considered of sufficient importance to be locked. The handle of the lancet, which is in the form of a narrow oval loop, is made of bronze, and has at the far end from the blade a small projection, from which something has been broken, probably a knob. A small disc forms a sort of guard to the

blade, which latter is of steel, and still so sharp that a very distinguished surgeon of modern Shrewsbury tells me that he thinks he could almost perform an operation with it in its present state. The lancet has been contained in a wooden case or sheath, lined internally with leather; and the more considerable fragments of the wood, which is rather coarsely grained, and leather lining of this sheath, are represented in our cut.

ROMAN LANCET AND FRAGMENTS OF ITS CASE.

Thus it is evident that there were in Uriconium surgeons who, whatever may have been their skill in operating, had, at least, perfectly good instruments for the purpose. It is not improbable that, as in the middle ages, so in the Roman towns, the practice of the surgeon, or chirurgus (χειρουργὸς, the man who operated with his hand), was entirely distinct from that of the physician, or *medicus*. We have, also, in the Wroxeter Museum at Shrewsbury, a very curious memorial of the medical

practice in ancient Uriconium. It is one of what are usually called Roman oculists' stamps, consisting of an inscription engraved on a neatly formed round slab of whitish stone, rather more than an inch in diameter, intended, of course, for impressing the names of the medicine and its maker on the pot, box, or parcel containing the former. Our inscription may be read as follows :—

TIB CL M	Tib*erii* Cl*audii* m*edici*
DIALIBA	dialib*anum*
AD·OM	ad om
NE·VIT	ne vit*ium*
O EXO	*oculorum* ex o*vo*

It may be translated, "The dialibanum of Tiberius Claudius, the physician, for all complaints of the eyes, to be used with egg." This object belongs to a class of Roman antiquities which are by no means uncommon. More than half a dozen have been found in Britain, and a greater number have been met with in Gaul and Germany. Of those found in England, the localities of the discovery of five only are known, and, curiously enough, these are all on the western side of England, on the sites of the towns of Uriconium (Wroxeter), Magna (Kenchester), Glevum (Gloucester), Corinium (Cirencester), and Aquæ Solis (Bath). It is also remarkable that all these stamps yet known are for ointments and other medicines for diseases of the eyes ; and we seem thus justified in assuming that diseases of the eyes were very prevalent among the population of Western Europe under the Roman empire. We have not a sufficient knowledge of the sanitary condition of society at that time to enable us to state why this was the case. Most of these stamps are engraved on small parallelograms of stone, and occupy the edges, so that there are from two to four different inscriptions, for so many different medicines made by the same physician, all for eye-diseases, and all expressed in much the same formula. Thus, the example found in our nearest neighbouring Roman town, where they occurred, Kenchester, has four inscriptions, and that found at Cirencester two. One of the inscriptions of the Cirencester stamp may be given as an example. It is in two lines, and may be read,—

MINERVALISDIALEB	Minervalis dialeb
ANVMADIMPETLIPEXOV	anum ad impet*um* lip*pitudinis*, ex ovo.

"The dialebanum of Minervalis against lippitudo, to be used with egg." Of all these stamps yet found, no two bear the same name, from which we are justified in considering that the names are those of the local practitioners to whom each belonged. The specific of Minervalis, as it will be seen, was a similar ointment to that sold by Tiberius Claudius, the physician of Uriconium. The dialebanum was a well-known ointment for

the eyes, made originally of a vegetable substance, said to have been procured in its greatest purity from Arabia; but no doubt these local doctors used other substances in its place, and probably each pretended to greater perfection than his neighbours. In the Cirencester inscription, as in that found at Wroxeter, it is directed to be used *ex ovo*, or to be applied beaten up with egg. It has been supposed that these stamps belonged to oculists only, but the presence of the term *medicus* can leave no doubt that the individual to whom our stamp belonged, Tiberius Claudius, was a general physician of Uriconium.

Neither of these curious monuments of the civilization of a far-gone past, the lancet or the medicine stamp, give us any room even for a conjecture as to the part of the city of Uriconium in which the surgeon or the physician dwelt, the manner in which he exercised his profession, the social position which he held, or even the exact period at which he lived; but this is not quite the case with the objects to which the attention of our readers is next called, and which belong to a profession of an entirely different character. It may be necessary, in explanation of this discovery, to state briefly that the principal buildings we have been laying open at Wroxeter consist of the Basilica or municipal hall, an extensive edifice running east and west, and opening in the latter direction upon the forum; the public baths, attached to the basilica on its southern side; and a long block of buildings between the baths and the forum. Among the last-mentioned buildings, and not far from the same spot, were found, at different times, three small rectangular slabs of a whitish stone, apparently steatite or soap-stone, which had been carefully smoothed, the one side presenting a perfectly level surface, but the other bevelled off at the edges. They are nearly of the same size, about two inches and a-half broad by two inches and three-quarters long, and not quite half an inch thick. A very slight examination was enough to show that these were painters' pallettes. They are represented in our cut, in which it will be seen that the one to the right is very much worn in the middle of the upper or unbevelled side by the action of the painter rubbing his colours, and, indeed, traces of the colours may still be perceived. This pallette had been accidentally broken, and the fracture as here shown will give a better notion of the form of the pallette, and of the character of the wearing, than any description. We have every reason to believe, from the locality in which these objects were found, that there was a painter's shop, or studio, somewhere between the baths and the forum, so that the fine arts, perhaps, flourished in Uriconium. But one of these pallettes furnishes us with another fact of some interest connected with this subject. On

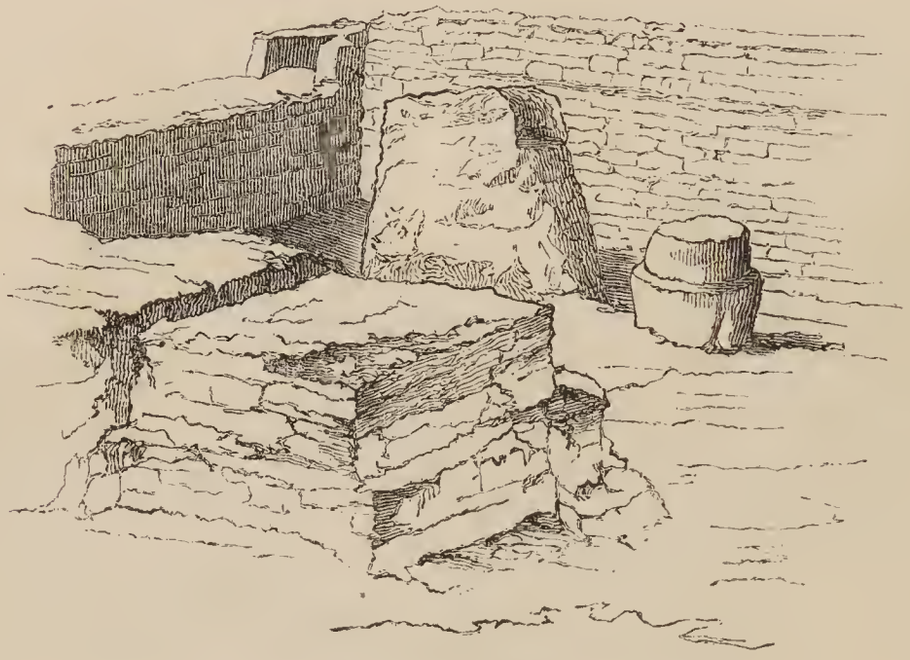
the back of this pallette, which is turned towards us in the engraving, and which has been less used than the one just described, we find, among several scratches made intentionally with a sharp instrument, a man's name, rudely but minutely written in a small tablet, evidently an imitation of the forms in which the potters' names are stamped on the red Samian ware. No similar inscription is found on the other pallettes, and, from the manner in which it has been executed, we are fairly justified in supposing that it is the name, not of the maker of the pallettes, but of the possessor of this particular example, and probably of the others also. From the careless manner in which this inscription is written, it is not very easy to decipher, but it appears to be DICINIVMA, which may be read as Dicinivi manu, by the hand of Dicinivus. Thus we

ROMAN PAINTERS' PALLETTES, FROM URICONIUM.

have, in all probability, the name of a professional artist of Uriconium, who flourished at the time when the town was destroyed, and which, certainly not Roman, would apparently show him to be either a Gaul or a German. All this is extremely important in its relation to the history of art, one of the most valuable measures of social refinement at this very interesting period. Our knowledge of the forms of the practice of art among the Romans is in some respects defective, although they appear in general to have resembled very closely those in use at the present day. We do not even know any distinctive name for the pallette, except the word *assula*, which means simply, like pallette itself, a thin slice or chip of stone, or other material. Wall pictures have been met with in Pompeii, in which the painter is represented at his work. In

one of these, which is a burlesque or caricature, the painter, seated before a very modern-looking easel, has a tablet of stone, supported on four legs, as a large pallette, on which he can spread a number of colours at the same time; but in another painting, which represents a female artist making a drawing of a statue of the bearded Bacchus, the lady holds in her left hand a real pallette, only differing from those I have just described in being oval instead of rectangular.

We have thus already discovered interesting memorials of the existence, in Uriconium, of an important branch of science, and of an equally important art—the healing science in its two branches of medicine and surgery, and painting; and we have brought to light the names of a physician and painter, who lived, and no doubt flourished, in the Roman city. We must now descend to a profession which may perhaps be described



INTERIOR OF ENAMELLER'S SHOP IN URICONIUM.

as of a less elevated character, though I am not sure that it also did not belong to a high degree of art. Moreover, it is a case in which we can identify the spot on which the art was practised. We opened a large, square room, of about thirty-eight feet by forty, a little to the south of the Basilica, and adjoining westward to the forum, which proved to be the workshop of an artificer in metals. Towards the north-eastern corner of this room stood a pile in the form of a sugar-loaf, about six feet high, built very roughly of clay, mixed with stones and other unprepared materials, among which were several lumps of unburnt mineral coal, which prove that that substance was sufficiently abundant in Roman Uriconium. On the eastern side of this structure, near the top, was a small furnace, in which there had been a fire so intensely hot that the whole internal surface was vitrified to some depth. From the form and posi-

tion of this little furnace, it is quite evident that it must have been heated by a powerful blast, no doubt of bellows, which, with their machinery, have long disappeared. By the side of this furnace, towards the interior of the room, stands upright a rudely-formed cylindrical stone, resembling the stump of a column, which was evidently used, in some way or other, for working metals which were melted or rendered malleable in the furnace adjacent. The form and position of these objects are shown in our cut; and another cut will enable me to illustrate, if not satisfactorily explain them. We find in engraved gems, and in other works of ancient art, rather numerous pictures of the forge of Vulcan, and of other scenes of a similar description, in which are represented both the furnace and the anvil. The first of those here represented, that to the right, is taken from

ROMAN ANVILS.

a sepulchral marble at Rome; the second, which represents Vulcan forging the thunderbolts for Jupiter, is furnished by a gem in the Cabinet Royal at Paris; and the third is taken from another engraved gem. I might easily add other examples, but it will be sufficient to remark that the form of the stand of the anvil is invariably the same—a short cylindrical stone, or stump of a column. On comparing these with the object in our room at Wroxeter, and considering its position, we can hardly hesitate in considering the latter to have been the support of an anvil. Now it happens, curiously, that in clearing the ruins of some of the buildings at but a short distance from this spot, a large lump of iron was found which had evidently been exposed to the action of fire, and from that cause, and the effects of decomposition, presented no very intelligible form. It lay upon a low remnant of a broken wall, as though it had been dropped there, and had evidently been carried away from its proper place. But, when examined a little more carefully, this lump of iron presents very evident appearances of having formed an anvil; and I feel convinced that it was

the anvil which once stood on the cylindrical block of stone before described, which would then still more exactly resemble the figures I have given from the ancient gems. Some one, probably at the time when people were breaking up the ruins to carry them off as building materials, seized upon this piece of iron, and would have carried it away also; but, finding it heavier than was convenient, he let it drop in this spot, and it was left there.

The smallness of the furnace is enough to convince us that the metal-works made on this anvil were not on a large scale; and there are other circumstances connected with the room itself which require consideration. Its front, bordering upon the forum, appears to have been open to the street, like the shop of a modern coach-builder, in two openings, separated by a pier of masonry, and no doubt capable of being closed with woodwork. The sides, indeed, are grooved for this purpose. On this side of the room, internally, there was a smooth floor of cement, nearly level with the sill of the entrance opening, and extending not quite to the middle of the room. Beyond this there is a floor at a much lower level, formed entirely of a very fine sand, which has been brought from a distance, and placed to a considerable thickness upon the natural soil of the spot. The only use we can easily imagine for this sand would be to form moulds for casting, and various other circumstances seem to show that this was in fact a workshop for the fabrication of small objects in metal. A considerable quantity of the scoriæ from molten metals were found scattered about here, both within the room and outside; and many fragments of worked metal, with about a dozen bronze hair-pins, a large bronze fibula, and various other objects, were picked up in the room. The floor of sand had been supported on the northern side by a low wall, between which and the northern wall of the room there had been a kind of pit, in which were found many pieces of scoriæ, and other apparent articles of refuse. On one side of the room, upon the sand, was found a quantity of pounded granite, which, I am told, might be used for the purpose of enamelling; and many fragments of fine glass were also scattered about. The occupants of this shop appear to have left it hastily, when the town was taken by the barbarians; for one of them, as he passed over the sill of the front opening into the street, dropped his money, which had been kept in a small earthen vessel, which he may perhaps have returned to his shop to fetch, when he was surprised by the plunderers as he was leaving. The little pot was found on the sill, near its northern end, at the spot shown in our cut of the furnace and anvil-stand, broken, and the money lying a little scattered about it. Among the latter was

found a small, thin disc of metal, which had no doubt been intended for a button or stud; its face very prettily ornamented, not exactly in enamel, but in work more resembling what is called "niello," or work not much unlike damaskeening. With it were also found some fragments of small globular ornaments, of such delicate make that they were too much broken to pieces to allow us to judge satisfactorily of the real character of the object to which they belonged. The stud, or button, had evidently, when dropped in the place where it was found, been fresh from the hand of the maker, and there is nothing opposed to the supposition that it was made in the workshop I have been describing, and which, therefore, may be assumed to have been that of a manufacturer of ornaments and small objects in metal, including, perhaps, the practise of the art of enamelling. It must be stated further that, on the higher floor of cement, near the south-western corner, there are the remains of another furnace, which was built of masonry, and heated by means of a flue; and that in the middle of the room there is a square mass of rather rough masonry, with a level surface about the height of the floor, which has either been intended to support some heavy object, or possibly to serve as a work-table. This mass of masonry is shown in the front of our cut, given above, with the higher floor to the left of it, and the lower floor of sand before it and to the right.

The existence of this workshop, and the manufacture of enamels and niello in it (if the conjecture be correct), would form an interesting fact in the history of mediæval art. There are reasons for believing that the art of enamelling was practised at a very early period in Western Europe; indeed, it has been supposed to have been invented in Gaul. It would be curious, therefore, to find the remains of an enameller's workshop which had been in active operation in a city of Britain at so early a date, and that on an apparently rather large scale. It would lead us to suppose, also, that the Anglo-Saxons, who were celebrated also at a very early period for their skill in the manufacture of jewellery, and in goldsmiths' work in general, had learnt their art from the jewellers and enamellers who remained in the Roman cities which had not been destroyed.

In calling attention to these few articles of antiquity belonging to a particular class, I would again repeat that, found within so small a compass as our researches have as yet extended, they must be taken only as evidence of what interesting discoveries we may yet expect if we are enabled to go on actively in our explorations. It is already certain that science and art were not unknown in Uriconium. We have only opened one building which was not of a public character, and that has turned out to be the shop of an artizan in metals.

To the south of this, still facing the forum, is an extensive building, which appears to have been a market-place, or a store-house of some kind or other, and which requires farther examination. On the north, between the metal-worker's shop and the Basilica, with its front likewise to the forum, is another large, square room, which seems, like the workshop, to have been entered only from the forum, but which we have only yet examined sufficiently to assure ourselves that the walls internally are covered with stucco, or fresco. The opening was begun at the commencement of the season which would have been destructive to wall-paintings, and it was, therefore, abandoned temporarily. The excavations have since been carried on in other localities of the site of the ancient city, but slowly, in consequence, I regret to be compelled to state, of the paucity of funds at the disposal of the excavations committee.

PROTEAN ANIMALCULES.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopical Society of London.

The older microscopists were much struck by the discovery of minute gelatinous creatures which, like the fabled Proteus, continually changed their form. Specimens of this family are very common in fresh and salt water, and they belong to the lowest order of the Protozoa,* if we except those which have a vegetable origin, and are not known to assume distinct animal characteristics. This order is named *Rhizopoda*, "root-footed," or *Pseudopoda*, "false-footed;" the first name intimating that their locomotive organs are like rootlets, while the latter points to their being distinguished from true feet. Simple as these beings are, they yet admit of divisions marking certain advances in organization, and they are separated by Dr. Carpenter, the great authority on this subject, into Reticularia, Radiolaria, and Lobosa. Our present business is with the third of these divisions, but their position in the world of nature would be unintelligible if we did not say something about the two which precede those in our list. The Reticularia are composed of a homogeneous granular protoplasm, with neither the nucleus nor the contractile vesicle which characterize higher forms of infusoria. Their *pseudopodia*, or false feet, are merely prolongations of the body, which can ramify

* First or elementary animals, distinguished from *Protophyta*, first or elementary plants.

minutely and adhere on contact.* In them we can trace no distinction between the substance which forms their surface, and that which lies below; in other words, they do not exhibit the difference between an *ectosarc*, or external flesh, performing the functions of an integument, and an *endosarc*, or internal flesh, which the former covers and protects. To the Reticularia belong the Foraminifera, whose minute shells are common on every shore, and enter largely into the composition of many strata in the globe. In point of time, the geologist assigns to them a venerable antiquity, and their diffusion in space extends over all climates, and the deep beds of the ocean which Dr. Wallich so ably explored. The Radiolaria have an *ectosarc* and an *endosarc*, and, some at least, a nucleus, or organ of reproduction, and a contractile vesicle. They are thus more highly organized than the Reticularia, and one specimen of them, the *Actinophrys sol*, is very common in fresh water. Some of them are in the water which furnishes the subject of this paper. They are irregular, granular-looking-globes, surrounded by slender pseudopodia, which stand out like the rays in old-fashioned engravings of the sun. Here are two pressed tightly together so as to flatten the adherent surfaces. They are in process of conjugation, and had they been left in the bottle, a happy family of sun-animalcules would have been the result. The third division of root-feet is the Lobosa, in which physiologists trace the progress of *differentiation*, or distinctions of parts, carried to a somewhat greater extent. It contains one family, the Amœbina.

Although specimens of the *Amœbæ*, such as furnished the matter for this paper, might have been obtained from various localities, it may be worth while to mention their origin, as it shows the value of keeping any materials we have collected, so long as they are in a hopeful state. In the month of September I ascended the uncockneyfied mountain of Carnedd Llewelyn, which belongs to the Snowdon group. Soon after leaving a little inn between Conway and Llanrwst, the route lay for miles across an ascending tract of moor land, and over a road composed alternately of holes and big stones, terminating in a slate quarry bounded on two sides by magnificent walls of perpendicular rock. There were no donkeys, guides, grand hotels, or other nuisances of more frequented ways; but a gray stone, here and there, marked the direction to the summit which we sought. After a steady pull up, Horne and Thornthwaite's mountain barometer—a pocket aneroid—proclaimed an elevation of 2600 feet, and a bottle was then filled from a little pool in which moss was growing, in order that, on our return, we might

* See Reichert's observations on this subject, and on the supposed rotation of granules, in INTELLECTUAL OBSERVER, xii., p. 471.

make acquaintance with the microscopic mountaineers. The sun was shining above a great field of clouds, intersected by numerous lines of clear air, through which his rays streamed; and as the lights and the shadows fell upon the distant plains, they mapped the land out in their own way, magnificently overriding the demarcations of man. As we came down, twilight began to make her magic changes in the scene; the mossy ground became inconspicuous, and one after another the members of the stoney world around us started into prominence, and seemed to wake like pre-Adamite monsters from a sleep. Weird phantoms of this kind, which belong to mountain regions, explain many of the superstitions of their human inhabitants;

AMŒBÆ, OR PROTEAN ANIMALCULES, × 420.

but our present business is with the bottle and its living contents, and we must not linger over another theme.

A few Rotifiers, mostly of the common sort, and a good many Water Bears, were the chief objects found in the moss. It was brought to London, put in a larger bottle with half a pint of fresh water, and left alone in a warm room. An occasional inspection revealed nothing particular, till in the middle of December the Actinophrys was plentiful, and a good many Amœbæ appeared. The latter were very small, as will be seen from the drawings of their aspect, when magnified more than 400 diameters. My first subject was in the shape shown in fig. 1, and looked like a five-rayed star-fish, but so transparent as to be put out of view by the least excess or faulty inclination of the light. My wife readily responded to an appeal to

take his portrait, but before she could bring pencil and paper he had assumed the form represented in fig. 4. Every moment the change went on, and figs. 5, 6, 7 give some of the most curious of his Protean shapes. Imbedded in his substance and undergoing digestion were various minute particles, and the *pseudopodia*, or, as I am tempted to call them, false *arms*, stretched about in every direction, often raising themselves above the level, and standing with their tips vertically over the general mass. I have often before had specimens of Amœbæ under the object-glass, but these were the most lively, and executed the most varied motions I had seen. Some of their pseudopod performances resembled the motion of the tentacles in that beautiful anemone, the *Anthea cereus*. Scarcely, however, had the vital character of the temporary organ and its movements been admired, before it disappeared. In went the long legs, out went the soft body, like a drop of slime flowing down a window pane, till it lost its shape. Gulfs and bays were formed in the plastic matter, and promontories protruded, and then subdivided, like the forked and craggy headlands of the Cornish coast.

Having spent some time in viewing this individual, another was hunted up, which exhibited the star-fish shape, and he was kind enough to permit my wife's rapid fingers to take his pattern, as the figure shows (fig. 1). Drawing these moveable creatures is exciting work; you must watch like a sportsman in a cover, not knowing whether a pheasant will rush up above his head, or a hare spring from beneath your feet. I am looking on as a calm spectator, but I see the pencil dashed on the paper, and fig. 2 gives another of the Protean fits. I take a peep through the microscope before the inconstant creature makes a fresh change; but quickly one leg disappears. I summon my wife, who is again fortunate in depicting our Pau-puk-keewis in his biped state, fig. 3.

Our good friends, the Hungarians, put their Christian names after their surnames, and naturalists do the same, with the appellations they bestow; so that Kossuth Louis, or Diosy Martin, of good vinous celebrity, may be likened to *Amœba diffluens*, or *Amœba radiosa*, the two species which our Proteus, with a characteristic contempt for systems, rolls into one. Had he preserved the radiate form as his principal pattern, he would have justified the separate name which was invented for him; but he, like his predecessor, was obstinate on this point, and for an hour or two *slobbered* himself about—the word is expressive and archaic—without once reverting to anything nearer his original aspect than may be found in figs. 4, 5, 6, and 7. A similar observation is quoted in Pritchard from Claparède, who says, "It appears almost absurd to attempt the distinc-

tion of species amongst the Amœbæ, until we know something more of their intimate organization. Thus Ehrenberg's *A. radiosa* is characterized by the regularity of its processes and its generally stellate form when at rest; but when the creature creeps, it slowly expands, and the peculiar outline disappears; it flows along like a cloudy veil or drop of oil, and *A. radiosa* has became converted into *A. diffluens.*"

Let me warn microscopists who do not know these creatures that they often look like faint smears upon the glass, and in that condition no one would dream they were alive who did not wait until a change of form was seen. I found it desirable to view them with powers of about 400 and 700; the former being most generally convenient, as requiring less change of focus when they altered their shapes, and caused portions of their bodies to approach or recede from the glass. The achromatic condenser, using the smallest hole, and cutting off all the marginal light, was very useful. If without it, I should have employed the spermaceti disk, recommended in last number, as the porcelain-white ground thus obtained is favourable to the perception of very transparent bodies. The light reflected from the inner surface of the white shade of Mr. Pillischer's lamp has a similar property. With the achromatic condenser an ordinary lamp should be turned low, as anything like a blaze puts the object completely out of view.

Dr. Carpenter * says, speaking of the Lobosa, to which our Proteus belongs, "The distinction between *ectosarc* and *endosarc* is here clearly marked, so that the body approaches much more closely in its characters to an ordinary cell-wall and cell-contents. . . . The ectosarc, which is perfectly pellucid, forms an almost membranous investment to the endosarc; still it is not possessed of such tenacity as to oppose a solution of its continuity at any point, for the introduction of alimentary particles, as for the extrusion of effete matter." Thus, if partially divided, it can stick together again, and heal immediately; a condition like that of the Scandinavian heroes in the Halls of Odin, who received mighty wounds for amusement in the morning, but were always ready for a dish of pig in the afternoon.

The *Amœba princeps* is larger, and, I believe, commoner, than the two so-called species which we have examined. It is also of a yellow colour, and its processes are less threadlike and pointed than those which the *diffluens* can put forth. Pritchard cites the descriptions which various authors give of twenty-three alleged species of Amœbæ, but they must be received without much faith in their validity, being for the most part founded upon distinctions of no zoological value. The

* *The Microscope*, 3rd edition, p. 460.

difference between the ectosarc and endosarc can only be demonstrated by the use of re-agents, and naturalists will be generally disposed to agree with Claparède that divisions which are not based upon structure have little title to respect. The Amœbæ, whose animality is undoubted, *flow over* their meals and take them in at any part of their bodies. Whether those which have a vegetable origin take in foreign matter and digest it in this way, has not yet been decided. They may not be exponents of a transition from the vegetable to the animal world, but they are assuredly interesting connecting links, and with similar links help to bind the realms of organization into one infinitely varied and widespread whole.

EXCAVATIONS AT ROME.

Dr. Deakin writes, "I have just been to see the progress the excavators are making in the site of the Palace of the Cæsars. You will remember that this palace is situated upon, and in fact entirely covered, one of the seven hills of Rome, viz., the Palatine, and that in its present state it is about one and a-half miles in circumference; the whole hill is now a mass of brickwork, broken up into ruins of endless form, and in some parts covered up twenty feet beneath the present surface with broken fragments of brickwork, various kinds of marble columns, shattered slabs of marble which encased the walls, cornices and mouldings of various designs, some of them most elegant, and their angles as sharp as though the workmen had only just finished them; but they are all so broken up that it is rare to find portions larger than a truncated column; it is known, however, that these ruins have been a vast store-house, as it were, from whence materials were taken for the erection of other buildings, and that even in the time of Sixtus V. he had materials from this ruin, and probably from the Colosseum, to assist in building St. Peter's, and how many of other churches and buildings have been erected from these ruins it is impossible to know; it is therefore not to be wondered that the remaining mass which covers up the foundation of the building should be as it is found, chiefly plaster and cement, mixed with only small portions of marble and comparatively few bricks and stone. No statues of any importance have hitherto been found, and it is probable that there are not any left that have escaped former excavators. There is, however, great interest attached to these excavations, as it is hoped that they will enable us to make, from the existing foundations, plans of the ancient palace and other buildings attached to it, and as the Palatine is

the hill upon which Romulus, the founder of Rome and the Romans as a nation, first established himself.

"The first object of attention upon examining the excavations is a portion of public road which leads up to the palace, and was a branch of the Via Sacra from the *Summa*, the spot where the Arch of Titus stands, and, like the rest of the road, it is formed of large irregular-shaped blocks of volcanic stone; one of these at the top of the ascent is about eight feet long and four wide, near this are the foundation of brick walls forming small compartments; in other adjacent parts are numerous long, lofty, arched passages, branching off into numerous others, and into small apartments, some of which it appears were dark, as there is no appearance of apertures for the admission of light; some look as though they had been baths, the walls encased in marble, and the ceiling adorned with frescoes representing dolphins, etc., emblematic of the sea or water. Many of these paintings are almost as fresh in colour as though they had been only lately painted; the walls and arches, which are very massive, are all built of bricks, but on the eastern side of the hill overlooking the site of the Circus Maximus, some structures have been laid bare formed of large squared blocks of tufa placed upon each other without cement between them, in the form of large pillars, about sixteen feet high, supporting arches; these it is thought are some of the earliest structures in Rome, being built at the period of the Roman kings—that is, between the years 753—510 B.C. They are of Etruscan architecture, and very similar to the Cloaca Maxima and the walls of the Mamertine prisons; these ancient foundations formed the substructure upon which Augustus built his imperial palace, and the remains of what was the celebrated Palatine Library, an academy which had three or four elevated seats round it in the form of an amphitheatre; besides these, the traces of other spacious halls may be seen, as well as the foundations of what is supposed to have been a portico, formed of numerous lofty columns. All these buildings were made of massive brick-work, and encased with marble slabs, some portions of which still remain, as well as part of the marble pavement. Much, however, must still be done in the way of excavations before we can form an idea of what the buildings erected here were; indeed the difficulty of forming any accurate plan is very great, as the remains of former buildings which have been destroyed have been made use of as the foundation for others, and these again altered, and other portions added by various emperors at different periods."

THE MERLIN.

(*Falco Æsalon.*)

BY ROBERT GRAY,

Secretary to the Natural History Society of Glasgow.

THERE is nothing in the possession of an ornithologist of greater interest to him than well-preserved skins of those birds which he has himself captured. Nearly every specimen recalls adventures by "flood or field," and presents memorable pictures more vividly, indeed, than the famed sketches of Joseph Wolf, whose unrivalled pencil may almost in this respect dispute the claims of any collection, however distinguished. Even though the collector should possess several birds of the same species, each may have its own romance, investing the dried skin with all the advantages of a note-book, and calling up recollections of bird-life by the sea-shore or mountain side, by peaceful glens, and brawling rivers.

In Scotland especially, where scenery is so varied and bird-inviting, these remarks suggest themselves naturally to any one engaged in ornithological pursuits, its friths and forests being yet the dwelling-places of species long since rare in the south, and its mountains yet honoured by the eagle's throne. Inland waters still protect the wild goose and phalarope; rugged headlands the erne and the peregrine; and through the long summer months, on the Hebridean shores, the loud and melancholy cry of the great northern diver strikes on the ear. To be one's self the medium, therefore, of obtaining these desirable birds is no fireside matter, but involves journeys of hardship and endurance, and sometimes adventures not without risk, but all more than repaid by the objects of pursuit, placed, it may be but occasionally, before the eye for inspection, though never failing to bring back pictures of places for ever gone to the sight.

The following observations on the Merlin have been suggested by an examination of three fine specimens in my collection of birds of prey. They were shot by myself. There is nothing particular to narrate in connection with these three but the offences for which they were convicted. One, a young bird of the first winter, was cut down in a juvenile foray amongst a covey of partridges, probably his first infringement of the game laws; another disregarded my fowling-piece at thirty yards after lifting a barn-door duckling; while the third was killed as he seized a towering snipe, and fell with a splash, prey in hand, into the marsh whence the prey had risen. As they lie on the table before me they carry the mind to distant

scenes with a peculiar vividness, recalling not only the interest of their own capture, but reminding me of impressions of their haunts and birthplaces, like the nameless mountain stream—

> "Over the moorland, purple dyed,
> Over the rifts of granite grey,
> Up to thy source on the mountain side,
> Far away—Oh, far away."

The Merlin is extremely interesting from its daring spirit and activity in pursuit of prey. It will rush headlong anywhere when fairly excited, and is rarely baffled in its hunting expeditions, however large the object of chase. I have seen one, however, follow a wheat-ear into a rabbits' hole, coming out unsuccessful, and darting away with a peculiar suddenness, after shaking the sand from off his back; and the handsome little fellow now in my hand had missed a rock pipit twenty times before he dashed among the partridges. The pipit darted hither and thither in such fear and perplexity, that by its zig-zag movements it fairly defeated the aim of the Merlin as he rose and came down to clutch it. But it does not often allow its prey in this way to escape, the chase being usually persisted in with a courage and determination quite extraordinary in a bird so small. With the rapidity of an arrow it will fly along some enclosure, by the hedgerows, seize an object, and glide out of sight, leaving the spectator to marvel at the transaction as at a deed of magic. It is, indeed, almost impossible on such occasions for the eye to follow its movements.

On the east of Scotland, where I studied the habits of raptorial birds for many years, I remember some years ago seeing this falcon capturing snipes very cleverly at the sea-shore. At a particular part of the coast, near Dunbar, where a rivulet enters the sea, the snipes fed in great numbers at low tide, the ground, which was covered with small brown pebbles, being well adapted for the concealment of birds. With the most punctual regularity a pair of Merlins used to come, as I made my appearance every morning at this place, and hover about till I had raised a brace, which were immediately pounced upon. But after a time the snipes became so terror-stricken that a hundred shots would not frighten them; nor could a single bird be raised, though I saw them occasionally skulking under the stones. I found them more than once indeed paralyzed with fear, and so heedless of anything save the hawks, that I was able to pick up one or two and transfer them to my bag, while my two friends were flying overhead, disappointed of their usual supply, and doubtless in wonder at this sporting novelty. Ultimately, however—for the snipes persisted in frequenting the place, though an unusual one—these birds acquired so much cunning, that they ran to conceal themselves

under the slimy stones below tide mark, thrusting their bodies, crab-like, into the crevices as soon as these Merlins and I came in sight! At such times their hurry was very diverting; and as the facts I narrate extended over a length of time, I could not help being struck with the behaviour of the snipes during the protracted disturbance they were subjected to.

The Merlin makes its nest, as I have observed in various parts of Scotland, in wild tracts of moorland amongst heather, the spot selected being generally near a ravine or moderate precipice of rock, on the summit and walls of which tufts of heath are growing. The nest is composed of small sticks and stalks of heather, but is without any lining. The eggs are from three to five in number, and of a dark, close-grained red, subject to almost no variety. They are, in fact, more easily recognized than those of other rapacious birds. I have specimens from Kinross-shire, Argyleshire, and Aberdeenshire, and all are closely alike. The bird itself is found, I should think, in almost every Scottish county. I have observed it to be tolerably common in East Lothian, especially on the sea coast, where it could satisfy its partiality for shore birds. It seems to prefer sanderlings, dunlins, and snipes, these being oftenest found in its nest, though it be situated on some moor at a considerable distance from the sea. I have seen it also killing larks.

I remember on one occasion finding a Merlin's nest on one of the Haddingtonshire moors, by the side of a ravine filled with great square blocks of gray rock, and clumps of feathery birch-trees, the banks being decorated with patches of beautiful heather and luxuriant grass. On a little platform near the summit of one of these blocks, which appeared ready to tumble into the glen, the nest was placed beside a tuft of heath, with three fine stalks of foxglove bending slightly forwards and gracefully shaking their bells over the heads of the young falcons as they sat waiting an arrival. I was about ten feet above them, peeping over the embankment under a spreading hazel, and well out of sight of the old birds should they come. They sat like miniature eagles in a line facing the course of the tumbling burn at the bottom of the ravine, and I could discern nothing like an impatient look in any of them. They appeared to be in full feather, and I could not help admiring the four healthy fellows, in an attitude of repose, on their picturesque watch-tower, even though it savoured badly of unfinished dinners and the trampled remains of seafaring dotterel. Taking an old letter from my pocket, I tore off several bits and let them down in a shower on their backs, which had the effect of making each give his neighbour a smart rap on the side of the head, and lift first one foot then the other, as if the perch were becoming too hot for them. But just as

I was about to repeat the infliction, their mother pitched down suddenly beside them with a golden plover in her claws, which she laid down unconcernedly, as I thought, but in reality relaxing her grasp with a truly inquiring look at so many visitor's cards on the premises. In an instant she looked in all directions, and at once divining nothing good from my head between her and the sky, she disappeared like a thought. I then took a stick and threw it down upon the family, who broke up by falling and fluttering into space till they fairly took wing and glided from me in different directions; so, as they had not touched the plover, I scrambled to the deserted platform and carried it off. It is not likely they would miss it, as I have no doubt that within the next half hour the little rascals were killing their first bird on the adjoining moor.

The Merlin breeds on the island of Benbecula, one of the Hebrides, whence I procured both the bird and its egg, last summer. A beautiful male from this interesting locality is one of the richest coloured I have seen, the blue on the back and buff orange on the neck and thighs being very pure. This specimen is but ten and a half inches in length. Another male before me measures twelve inches, while the female is thirteen. In the month of July last a friend trapped for me on an Argyleshire moor two old birds and their four young ones, just fledged. They were despatched to me alive and uninjured, but to my regret I found the male had died on the journey, and was trampled into a shapeless mass by his fellow prisoners. There is but little difference between the plumage of the female and that of a full-feathered young bird of either sex; but in some adult females I observe several blue feathers appearing on the back, as if in process of moulting; a circumstance which induces me to remark that at a recent meeting of the Natural History Society of Glasgow, Dr. Dewar observed in connection with the peregrine falcon, that he had shot females on their nests having the whole of the upper plumage spotted with blue feathers. In the first case are we to suppose that the female Merlin at a certain age occasionally assumes the plumage of the male, or, in the other, must we believe that the peregrine falcon breeds before arriving at maturity?

QUETELET ON SHOOTING-STARS.

M. Quetelet devotes a chapter of his *Physique du Globe* to "Shooting Stars," and the following passages contain the most interesting information in a condensed form. He tells us that the first efforts to observe these bodies in a scientific way were made by two students at Göttingen, Brandes, and Benzenberg, who began their labours in 1798, and published their first researches at Hamburg in 1800. Olbers and Chladni encouraged these young men, but attention might not have been generally excited to the subject if Humboldt and Bonpland had not astonished the world by their account of the splendid shower of falling stars which they observed in America on the 15th of November, 1799. In 1824 Quetelet took up the study of these bodies at Brussels, especially with a view to determine their heights, velocities, and trajectories—subjects on which the two young Germans had previously laboured. In 1837 Benzenberg addressed a long letter to Quetelet, describing the investigations in which he had been engaged. He considered, with other authorities, that shooting-stars were stones ejected by lunar volcanoes, and circulating round the world by millions. Having this notion he called the moon an "inconvenient neighbour."

In 1836 M. Quetelet informs us that only five cases existed in which the velocities of shooting-stars had been calculated, and in the following year he invited a general concurrence of observers in various countries. The 13th of November was ascertained to be the date of the annual recurrence of the phenomena on a large scale in America, while the 10th of August had been found prolific in Europe. In six cases M. Quetelet computed the velocities of falling stars, and obtained an average of five leagues, each equal to a twentieth of a degree, per second. Various opinions were given as to the number of these meteors on ordinary nights, and Sir John Herschel thought a single observer might reckon upon seeing sixteen per hour, and would not consider the night extraordinary if he did not see twice as many. The pupils of the observatory in Paris, each looking to one half of the sky, had noticed forty to fifty per hour, but Arago reckoned twelve to fifteen as a mean quantity. In America, Mr. Herrick spoke of fifty or sixty an hour between three and six o'clock a.m., and about twenty-five from six to ten p.m., as being about the total number visible. M. Quetelet remarks, "I will not insist upon the quantity a single observer may see, but there is an important distinction to establish, which is, that the latter part of the night offers double the chance of the beginning. This, if proved, would

be a strong argument in considering the probable origin of shooting-stars."

During their passage, shooting-stars sometimes emit a series of sparks, or leave behind them a luminous train, the duration of which varies. Their colour likewise differs, and sometimes changes during the passage of the same meteor. The straight course which they generally appear to take is not invariable, for in some cases a sensible curvature is noticed, and on rare occasions one may be seen to deviate abruptly from its primitive direction.

So far back as 1762, Musschenbroek observed in his *Treatise on Physics*, "that shooting-stars were often seen in spring and autumn," and in another passage he specially indicated their appearance in the month of August. This appears to have been forgotten when Humboldt published his account of the showers of these objects which he witnessed in America.

In an article published by Schummacher, in his *Year Book*, Olbers observed, that an immense quantity of planetary corpuscules, forming shooting-stars, appeared to move in orbits round the sun, and traverse the earth's orbit between eighteen and twenty-one degrees of Taurus. The orbits of the bodies were approximated and nearly parallel, and they furnished routes for myriads of infinitely small asteroids, whose revolution, he considered, was completed in from three to six years. Moreover, they appeared to be very unequally distributed, being densely accumulated in some portions of the orbit, and thinly scattered in others. M. Quetelet remarks that it "must be observed that the group of shooting-stars of the 11th and 12th of November has been scarcely noticed for ten years," and he asks "whether it has actually disappeared, or whether there is a certain periodicity in its returns." He adds, during the last century the months of August and November were already noted for the frequency of shooting-stars; and that the idea of singling out the 10th of August was suggested not by Musschenbroek, but by his own researches, and it seems that a quantity of these meteors was observed on that day in the years 1800, '1, '6, '9, '11, '13, '15, '18, '19, '20, '22, '23, '24, '25, '26, '27, '28, '29, '30, '31, '33, '34, '35, '36, '37, '38, '39, '40, '41, '42, '44, '45, '47, '49, '50, '52, '53, '55, '56, '57, '58, '59, and '60.

After M. Quetelet had pointed to the 10th of August, a manuscript of a work in the last century was shown to him, in which the same date was associated with *meteorodes*, and Mr. Forster, in his *Pocket Encyclopædia of Natural Phenomena*, stated that the Roman Catholics of Ireland had a tradition representing the shooting-stars of this period as the burning tears of St. Lawrence, whose *fête* was on the very day. *Silliman's Journal* also cites a Thessalian belief that the heavens

opened on the night of the transfiguration, 6th of August, and permitted the celestial *candles* to be seen. M. Biot likewise is of opinion that the appearances of shooting-stars in August and November are the same as the phenomena which are made to figure fifteen days later in Chinese catalogues.

M. Coulvier-Gravier has put forward the opinion that the meteoric appearances of August tend to grow less every year; but the records of observations do not indicate any law of decrease, and in some years, such as 1843, '46, and '51, the weather was extremely unfavourable at that date. In addition to the November and August periods, M. Quetelet finds the nights of the middle of October, and those of the 7th of December, and 2nd of January, prolific in shooting-stars.

M. Quetelet gives an elaborate table of the chief appearances of shooting-stars, from the earliest records down to 1860, and it is not surprising to find that superstition had often connected their movements with "wrath to man." In 1726 one of the most brilliant star-showers appeared in Europe, and at eight o'clock in the evening of the 19th of October, an observer at Liege states that for two hours the sky was inflamed by these meteors, so that it was easy to read or distinguish objects.

Arago remarks that falls of aërolites, appearances of bolides, and sporadic shooting-stars are much more numerous from July to December, than from January to June. "The earth," says this philosopher, "meets with a much greater number of cosmical meteors in proceeding from its aphelion to its perihelion, than when moving from the perihelion to the aphelion."

Concerning the origin of shooting-stars M. Quetelet remarks that opinions have varied most amongst those who have devoted most attention to them. They have alternately ascribed to these meteors a cosmic or an atmospheric origin, and the cause of the hesitation appears to be "insufficient and false notions of the constitution and height of our atmosphere." Moreover, "they have not on any single occasion been able to see or touch the substance of a shooting-star." Up to the present time M. Quetelet says it has been admitted without contradiction that our atmosphere is of uniform composition from the earth's surface to its greatest height, estimated at sixteen or twenty leagues, and its movement has been supposed coincident with that of the globe. But, he asks, are these assumptions true? "If," he proceeds to observe, "the action of other bodies in the neighbourhood of the earth was *nil*, the atmosphere, under the sole influence of its weight, would remain adherent to the globe, and uniformly partake of its movements as we suppose. But during the day the air is

unequally heated throughout its height, and particularly near the earth, where it is dilated by the direct rays of the sun, and by those reflected from the soil. This double heating is the more felt in proportion as the layer which it affects is denser than those which are above it." Then, as explained in our last number in the article on "Atmospheric Electricity," the atmosphere is divided into two portions, the one uppermost *stable*, and the other lower and *instable*. The height of the latter will vary according to the season, and the amount of heat acting upon it. In the lower or instable region, rain is prepared and storms burst forth; while in the higher and calmer region, M. Quetelet considers that the phenomena of auroras, shooting-stars, and the "great magnetic changes which manifest themselves by diurnal and monthly variations of the needle occur." The elements of this higher medium, destitute of moisture, are not "essentially" the same as those of the instable atmosphere, which, being constantly moved, is nearly identical in all its parts. It is difficult to estimate the height of the boundary which separates the two portions, but an approximation may be made by noticing cirrous clouds, which often stop at the base of the stable division, and which seems to be at least twice as high in summer as in winter. Similar indications, as explained in the article just alluded to, are given by electrical actions, which show that in winter the stable atmosphere, which from its dryness is a bad conductor, approaches nearer to the earth.

The stable part of the atmosphere differs, according to M. Quetelet, very widely from the ideas generally formed of it. Its height is three times what is supposed, and its composition may differ from that which is assumed. The best mode of studying it he considers to be by noticing its effects upon bodies passing through it like shooting-stars. These bodies become visible at elevations which may be estimated at fifty or sixty leagues; as they come nearer to the earth, their lustre increases, and they disappear completely as they approach the regions from whence we observe them, "as if they no longer found the elements necessary for them—as if they had passed into a medium which precluded their conservation." The instable atmosphere has its elements constantly mixed by motion and other causes, the stable atmosphere may permit them to separate according to their gravity. We may also ask whether the diurnal movement of the earth exactly corresponds with that of the atmosphere, and if the times of their revolutions are equal. This may be doubted, especially if we consider that the upper portion, which ought to have this movement, presses on the lower portion, which is continually agitated in an opposite direction. "Their movements of rotation ought naturally to differ, as in the planet Saturn the two portions of the ring

have a rotatory motion separate from each other, and from that of the planet. The rotation of our upper atmosphere differs in like manner, according to our view, from that of the rest of the globe, and thus affords a sufficient explanation of the displacement of the magnetic poles, and of other phenomena that would be difficult to account for in any other way."*

"If the atmosphere is regarded as described, it is not surprising that shooting-stars would traverse its upper regions, and be extinguished as they reach the lower portions in which we live. We also can imagine that auroras would generally arrange themselves along the boundary which separates the stable from the instable atmosphere, which is also the limit in which direction are found the magnetic forces that agitate our globe. These phenomena, which occur at moderate altitudes, may, by the same causes, be made to operate all over the northern hemisphere, and exhibit themselves with nearly equal intensity in Europe, and in the northern parts of Asia and of America."

M. Quetelet observes that shooting-stars are so common that no attentive observer will wait an hour without seeing one, although the latter half of both year and night are most prolific, and North America usually exhibits more than are seen in the "climates of Europe or Asia." These facts have not, he considers, been studied with the attention they deserve, although they seem likely to lead to the knowledge whether shooting-stars are produced in our atmosphere or enter it from without. The quantities of shooting-stars in different months and seasons are represented in the appended diagram, which we borrow from the *Physique du Globe*. The great outburst in August is followed by a striking diminution in September. In October there is a rise in the curve, which reaches its extreme winter range in November. In April, the curve reaches its spring elevation, which is much lower than that of the winter. In June the lowest period is reached, and with recurring August the shooting-star power once more culminates.

M. Quetelet noticing that shooting-stars appear to be confined to the upper and stable portion of our atmosphere, asks whether we are to ascribe to them some peculiarity which keeps them away from the earth, or to regard them simply as instances of ignition, the light of which can be seen from

* "We have seen," says M. Quetelet in a note, "that with us the magnetic declination will pass from a maximum to 0 in about 125 years, which gives a mean of 250 years as the interval between the maximum and the minimum instant, or 500 years as the period of the declination's needle's return to the same magnetic position. We suppose in this calculation a regular movement of the needle, which does not vary in the course of centuries. Does this movement take place because the magnetic pole is effectively above the earth, or does it arise from the influence exerted upon the atmosphere in general by a magnetic pole placed in the interior of our globe, and having a proper motion? This last hypothesis appears the most probable."

certain elevations, and becomes extinguished as the bodies approach our denser and perhaps different atmosphere. Shooting-stars must, he considers, be regarded as of a different nature from aërolites, bolides, and falls of dust.

Aërolites he considers as strangers to our globe, and, unlike shooting-stars which have never been touched, have frequently undergone chemical investigation, and present a tolerably uniform composition. Aërolites and bolides are very rare, as compared with shooting-stars.

Bolides are described by Arago as "globes of fire which

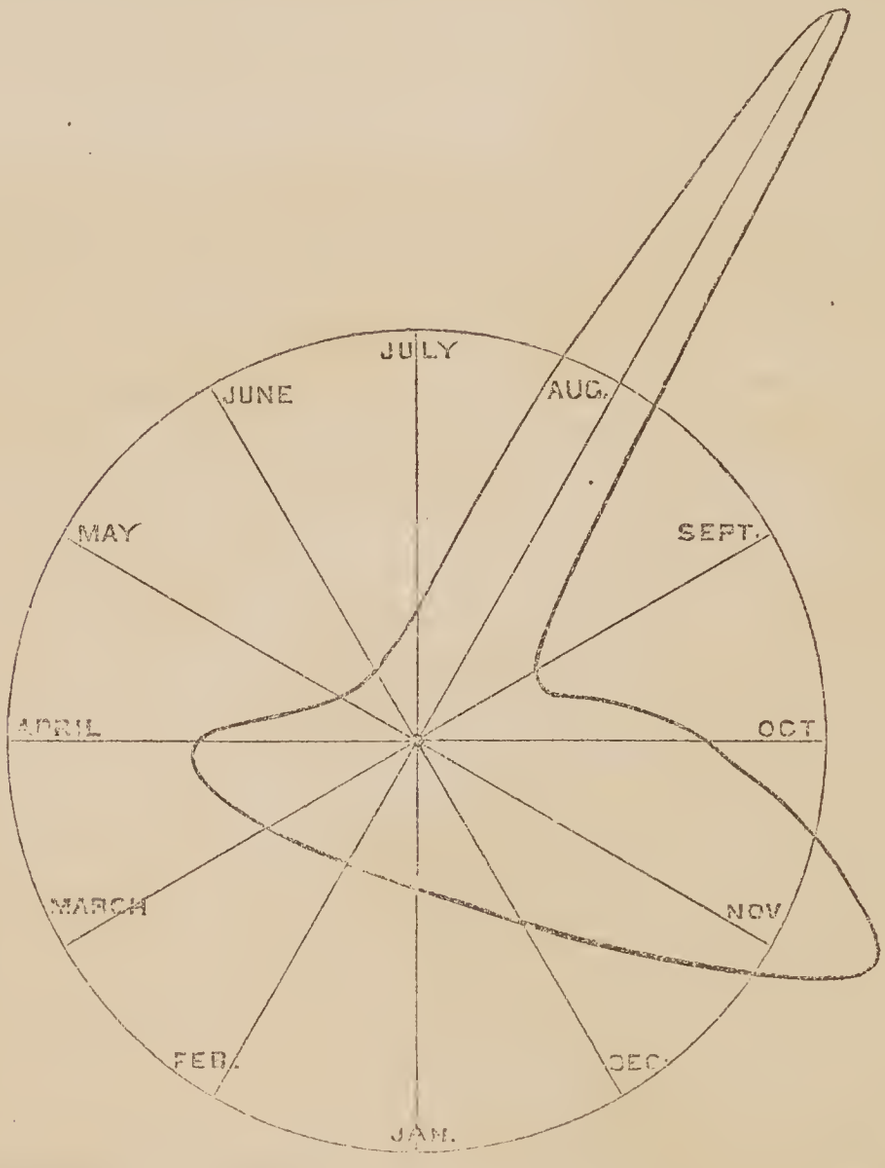
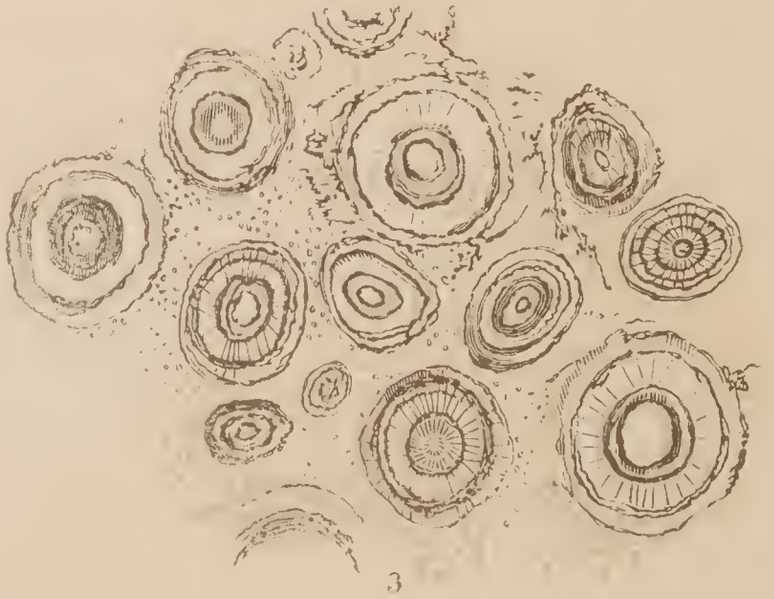


DIAGRAM SHOWING THE FREQUENCY OF SHOOTING STARS IN DIFFERENT MONTHS.

appear suddenly, and vanish forthwith, after spreading around them a brilliant light, which lasts for some seconds. Their form is circular, and they exhibit an appreciable diameter. They illuminate the horizon with a light usually rather weaker than that of the moon. They often leave a train behind them visible for longer or shorter time. Sometimes they burst into pieces, which continue their course, and are soon extinguished, and their fragments form the aërolites found on the surface of the earth." Dust-showers of materials similar to aërolites are much more rare, and appear to be of similar origin.

1

2



3

1. Tail of Opossum Shrimp.

2. Claw of Violet Crab. 3. Section of Crab shell.

STALK-EYED CRUSTACEA.

BY GEORGE S. BRADY, M.R.C.S.

(*With a Tinted Plate.*)

The "Stalk-eyed" Crustacea are more fortunate than their allies, the "sessile-eyed" tribes and the Entomostraca, in so far as they claim a large share of attention, not only from naturalists, but from that much wider class whose interest about them culminates in the achievements of Soyer or "Meg Dodds." Yet we do not know any reason, beyond their generally diminutive size, why the sessile-eyed species should be inferior in a gastronomical point of view to their stalk-eyed relatives,—why a dish of sandhoppers, for instance (especially of such giants as we have seen frisking on the shell-beach of Herm), should be worse than a dish of shrimps. We must confess, however, that we should need to be very hungry indeed before consenting to appease "the keen demands of appetite" by recourse to a fry of the great sea-slater (*Lygia oceanica*), no matter how juicy and well-favoured the specimens might be. After all, Mr. Gosse speaks well of the culinary qualities of *Bunodes crassicornis* (one of the common sea anemones) when cooked with egg and bread-crumbs, and if such a leathery animal can be made decently edible, we need scarcely despair of sea-slaters. In the Channel Islands the natives seem to eat everything that their shores produce, from "ormers" and spider-crabs, to hedgehogs and sea-urchins, the difficulty being to say what they do *not* eat. The quantity of the larger stalk-eyed species consumed in England and Scotland is prodigious. Mr. Bell tells us that from Norway alone not less than 600,000 lobsters per annum are sent to London, and from Scotland about one-fourth of that number, as well as great numbers from other parts of England and from the Channel Islands. Besides this species, the spiny lobster (*Palinurus vulgaris*), and the great crab (*Cancer Pagurus*), are extensively eaten, and the small Norway lobster (*Nephrops Norvegicus*) is brought in considerable numbers into many of our ports. It is much more delicate in flavour than the common lobster, though not held in nearly so great esteem. These, with the prawns and shrimps, are the chief species of stalk-eyed Crustacea whose economical uses call for notice.

Every Crustacean consists theoretically of twenty-one segments, seven of these being assigned to the head, seven to the

thorax, and seven to the abdomen; but in no one species can all these parts be distinguished, as several of them are always soldered together into one solid piece; it is only by comparison with others that their existence can be demonstrated, but the rule may be usefully borne in mind that every pair of limbs indicates the position of a segment. The seven segments of the head are compressed into very small space, and give attachment to the following members:—(1) the eye-stalks, (2, 3) the upper and lower antennæ, (4) the mandibles or jaws, (5, 6) the two pairs of maxillæ, (7) the first pair of foot-jaws. In the stalk-eyed species the thorax is entirely covered by a large shield or "carapace," which protects the more important viscera, viz., the stomach, liver, heart, genital organs, and branchiæ. The carapace consists of the seven thoracic segments firmly cemented together, from beneath which spring (1, 2) the second and third pairs of foot-jaws, and (3—7) the five pairs of true feet. The abdomen gives attachment to the five pairs of false or swimming feet, the swimming plates of the tail, and to two rudimentary appendages at the very extremity of the body. In the case of the common prawn (*Palæmon serratus*) all the members may be easily separated; but the division of the *body* is much better seen in the sessile-eyed Crustacea, which are destitute of a carapace, the rings of the thorax being separate and continuous from side to side.

In some stalk-eyed species, such as the crabs (*Brachyura*), the abdomen is very small, and is kept constantly doubled under the thorax; in others, such as the lobster, it is very largely developed, and constitutes a powerful swimming organ; nor need we be astonished at the prodigious strength of the animal's tail when we see the compact mass of muscle with which almost the whole abdominal cavity is filled, the sole purpose of which is to provide locomotive power. The flesh of the lobster exhibits the structural peculiarities of muscular fibre very beautifully, and may be advantageously used for microscopic preparations of this kind. If boiled before being used it will be found to split up much more easily into its ultimate fibrillæ. Not only the lobster, but any species of prawn, shrimp, or crab, will afford excellent examples.

Dissection of the lobster affords an admirable illustration of some most curious and interesting physiological phenomena. Supposing the animal to be dead, and the abdomen to be perfectly separated from the rest of the body, it will be found that when the muscular tissue of the abdomen is irritated by the scalpel, violent contractions are produced, the tail is forcibly flexed and extended, and the false feet flap vigorously. All this happens even though the creature may have been dead for

several hours, and the facts are easily explained by a reference to the structure of the lobster's nervous system. In the head there is a mass of nervous matter, not very large, which may be looked upon as the brain, and springing from it are two nerve cords, which run along on opposite sides of the body to its extremity, communicating on their course with certain smaller masses of nervous tissue termed ganglia, which lie laterally on each segment of the body. The brain and the ganglia are composed of gray nerve matter, and may be considered as the batteries or reservoirs of nervous force; the connecting cords, on the other hand, are composed of white nerve tissue, and are merely, so to speak, the wires which convey the force generated by the gray matter. Thus it follows that even when the head and brain are removed, there yet remains in the abdominal ganglia a sufficient supply of nervous influence to produce, when called into action, great appearance of vitality. And the means of calling it forth are simple. When the external or peripheral extremity of a nerve is irritated by the scalpel or other means, the irritation passes immediately along the nerve fibre to its ganglion, and is thence reflected along another fibre to the muscle, thus causing involuntary contraction. The nerve receiving the irritating impression is termed *afferent*, and that which transmits the motor impulse *efferent;* the whole series of phenomena being aptly termed "reflex nervous action." And all this may take place without the production of pain or sensation of any kind. Even in the higher animals and in man the same unconscious movements may be produced in cases where, either by disease or accident, the sensory ganglia have been injured or their communication with the motor tracts destroyed.

The ova of these Crustacea are very small in proportion to the size of the animal, but their number is enormous. Doubtless immense quantities of them fall a prey to the voracity of fishes while in their larval stages of growth, and it is certain that only an infinitesimal portion attain to full development. The transformations which they undergo have been briefly described in a previous number.* It is interesting to note these in connexion with the small size of the ova, as affording a confirmation of the theory of M. de Quatrefages,† that the amount of pabulum afforded by the ovum itself exercises great influence on the extent of development which takes place before hatching. We may observe also that the large proportionate size of the eggs of rotifers furnishes a strong reason against their being associated with Crustacea, and in favour of their claims to a place near the insects. The larval transformations

* Intellectual Observer, No. 6, p. 449.

† *Ibid.*, No. 8, p. 99.

being completed, further growth of the animal is provided for by a series of moultings. These take place annually until the full size is attained, after which it is believed that no further exuviation occurs. The moulting season is usually August and September. When it is about to occur, the creature becomes listless and timid, and retires to some protected hole or rocky crevice where it can shuffle off its calcareous coil in quiet and security. The process appears to be performed somewhat differently in different species. In some the feet are simply pulled out, as if out of a boot; while in others both the claws and the carapace are split up in determinate lines, thus allowing an easier exit to the animal. A great increase in bulk takes place immediately on casting off the old shell, so that seeing the newly emancipated crab and its cast coat side by side, it is difficult to believe that the one has so recently been the tenant of the other. The hardening of the new shell takes place very rapidly, and thus further growth is precluded until the moulting season again arrives. Mr. Gosse has given an account of the moulting of a Maia, or spider crab, which he was fortunate enough to have the opportunity of observing.* He says there was not "any of the struggling that is sometimes spoken of; it seemed to be a very easy and simple matter. The new integuments were perfected, though soft, before the old were thrown off, and the immediate cause of the separation of the crust appears to be the sudden growth of the animal within forcing asunder the upper and lower crusts at the posterior margin; then the pulling out of the limbs presents no more difficulty than what depends on the enfeebled condition of muscular energy."

The spontaneous rejection of limbs, and their complete restoration after having been so lost, are among the most remarkable endowments of this group of Crustacea. It is said that the noise of a thunderstorm or the report of cannon will cause crabs and lobsters to throw off their claws; and it is certain that the infliction of sudden injury will do so. When the injury has been produced without great or sudden violence, the limb is very likely to be retained, and the animal will probably bleed to death. In such cases fishermen are accustomed either to wrench the leg off at the first joint, or to strike it violently, so as to cause the creature itself to effect the dismemberment. In either case the wound heals over quickly, and the effusion of blood is stopped. Mr. Goodsir asserts that this salutary effect is produced by means of a glandular body situated at the base of the limb, which rapidly secretes a membrane over the stump, and in process of time entirely restores the missing part, though mostly on a smaller scale than before. Some species part with

* *Ann. and Mag. Nat. Hist.*, 1852, p. 210.

their limbs much more readily than others. The "*sleight* of hand" performances, for instance, of the little broad claw (*Porcellana platycheles*) are quite astonishing, so that among the multitudes which are often seen on turning over a stone near low-water mark it is not always easy to procure many perfect specimens. If nipped up by the claw they are almost certain to make off very quickly, leaving the limb behind in the grasp of your forceps or your fingers. This seems to be done without the least exertion; so easily, indeed, that it is impossible to suppose it other than a painless process. Even after being thus cast off the limb continues for some time to twitch spasmodically, thus increasing the suffering of any living thing which it may have included in its grasp.

Among the most curious of the stalk-eyed species are the Paguri or "Hermit Crabs." These animals have the front of the body only covered with the ordinary calcareous shell, the abdomen being quite soft and destitute of natural protection. But in order to obtain the requisite security the crab takes possession of the deserted shell of some univalve mollusc, into which he inserts his hind-quarters, remaining in it until his increasing size renders a more commodious tenement necessary, when he flits into a shell of larger dimensions. The common Hermit Crab (*Pagurus Bernhardus*) attains, when full grown, to a considerable size, adult specimens measuring about five inches in length, and requiring for their accommodation the largest shells of the whelk (*Buccinum undatum*). It is a question whether the crabs destroy and dispossess molluscs of their shells, or whether they merely appropriate such as they find empty. The fishermen in some districts seem persuaded that the former is the fact; but they are not always the most trustworthy observers.

A very interesting point in the history of the Hermit Crabs is the companionship which appears to exist between them and one of the sea anemones (*Adamsia palliata*). This pretty species is constantly found adhering round the mouth of univalve shells, and is almost always associated with some species of Pagurus, the crab appropriating the inside, the anemone the outside of the shell. Whether the companionship be more than accidental is not certainly known.

A still more curious instance of companionship exists in the genus *Pinnotheres*. These little crabs inhabit not dead and disused shells, but are actually co-tenants with the living mussel and pinna. It is only in the larger mussels that the creature is found, and the size of the crab with its claws spread is generally sufficient to occupy the full diameter of the shell. These crabs are quite soft, and no doubt incapable of existence except with protection of this kind; but the relationship gave

rise in old times to strange fables. Aristotle says,* "The pinnæ always contains a pinnophylax, either like a small caris or cancer, and soon die when this is extracted. . . . These animals apparently never grow, and the fishermen say they are produced at the same time as the creatures they inhabit." Pliny is much more amusing; he devotes a chapter to an account "of the nacre and his guide or keeper pinnoter, and the perceivance of fishes." The following passage gives his ideas respecting Pinnotheres.† "The nacre, also called pinnæ, is of the kind of shell-fishes. It is alwaies found and caught in muddie places, but never without a companion, which they call pinnoter or pinnophylax. And it is no other but a little shrimpe, or in some places the smallest crab, which beareth the nacre companie, and waites upon him to get some victuals. The nature of the nacre is to gape wide, and sheweth unto the little fishes her seelie body without any eie at all. They come leaping by and bye close unto her, and seeing they have good leave, grow so hardie and bold as to skip into her shell and fill it ful. The shrimpe lying in spiall seeing this good time and opportunitie ginneth token thereof to the nacre secretly with a little pinch. She hath no sooner this signall but she shuts her mouth, and whatsoever was within, crushes and kills it presently, and then she divides the bootie with the little crab or shrimpe, her sentinell and companion." It is needless to add that the greater part of this, however entertaining, is purely fabulous, the fact of the two animals being found in such close companionship having apparently suggested the other circumstances to the lively imaginations of the narrator or his informants.

The Crustacea afford many beautiful microscopic objects, yet they seem to have received no attention from those who habitually prepare mountings for sale. The colouring matter of the integuments is often disposed in very beautiful stellate or arborescent forms, an excellent example of which is given in the accompanying plate (fig. 1). The drawing represents a portion of the tail of the common Opossum shrimp (*Mysis flexuosus*), so called from the young being carried about in a sort of pouch for some little time after being hatched. Most parts of the body exhibit some arrangement of pigment, but the quantity and colour of it is in this species very variable, hence one of its specific names, *Chameleon*. In all cases, however, there is one large stellate mark in the centre of the back of each abdominal segment.

Another peculiarity of this interesting genus is the presence in one of the outer laminæ of the tail of a conspicuous

* Aristotle, *History of Animals*, Bv. 8, 9. Creswell's translation.

† Pliny, *Nat. Hist.*, cap. 42. Holland's translation (1634).

circular organ, showing two or three concentric rings. This is found to be an auditory apparatus, consisting of a membrane analogous to a *membrana tympani*, which encloses a small quantity of fluid. An expansion of an auditory nerve lines the membrane, and is kept constantly bathed in the fluid, constituting a remarkable analogue to the "vestibule" of higher animals. The beautiful disposition of cilia round the *caudal lamellæ* is also well seen in this drawing. There is, indeed, scarcely any Crustacean which does not exhibit most exquisite arrangements of this kind. The scales of the hard-shelled species are well seen on the claw of the little *Galathea squamifera*, a not uncommon species on most of our rocky shores, and known in some places as the "Violet Crab." Fig. 2 gives a representation of a portion of a claw. Under the "binocular" microscope and with a low power of two or three inches it is a most beautiful object. A section of the shell of the common edible crab (*Cancer Pagurus*) is given in fig. 3. This is made parallel to the surface, exhibiting a structure remotely similar to the bone of more highly organized tribes. The antennæ, and the hairs which clothe almost every species, will be found interesting subjects of observation; and for those who desire more than mere passing amusement the development of the ova —not a difficult matter providing a plentiful supply of sea water can be had—will afford scope for many an interesting investigation.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

BY CHARLES CHAMBERS.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1862. Day of Month.	Reduced to mean of day. Barometer corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	At 9·30 A.M., 2 P.M., and 5 P.M. respectively. Proportion of Sky clouded.	Direction of Wind.	Rain- read 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inche
Oct. 1	30·121	54·7	45·1	·72	·315	61·0	41·6	19·4	1, 3, 3	W by N, WSW, SW.	·02
,, 2	30·138	58·9	57·4	·95	·479	63·7	50·5	13·2	10, 10, 10	SW, SSW, SW	·03
,, 3	30·311	62·5	57·4	·84	·479	68·0	58·9	9·1	10, 5, 1	SW by S, W, W.	·01
,, 4	30·434	57·9	56·5	·95	·465	62·0	48·0	14·0	10, 10, 10	—, —, —.	·00
,, 5	...	...	...	...	...	62·4	49·0	13·4	...	... ...	·00
,, 6	29·998	58·5	56·5	·93	·465	64·4	51·9	12·5	10, 10, 10	ENE, —, NW.	·00
,, 7	30·042	50·1	44·1	·81	·305	57·0	49·8	7·2	5, 10, 10	NNW, NW, N by E.	·00
,, 8	30·305	56·6	51·8	·85	·397	61·3	49·6	11·7	8, 9, 9	NE, NE, NE by N.	·15
,, 9	30·244	55·5	49·3	·81	·364	59·9	52·3	7·6	9, 3, 2	E by N, ENE, ENE.	·00
,, 10	30·054	59·1	56·1	·91	·459	66·0	46·5	19·5	7, 3, —	E by N, NE by E, —.	·00
,, 11	29·848	57·7	54·4	·89	·433	63·0	53·6	9·4	9, 8, 9	SW, SW by W, SW.	·60
,, 12	...	...	...	...	...	63·3	51·6	11·7	...	... ...	·14
,, 13	29·838	54·4	49·4	·84	·366	61·3	49·4	11·9	9, 10, 10	SW, W by S, SW by S.	·15
,, 14	29·855	60·4	57·1	·89	·475	67·3	53·1	14·2	9, 10, 2	SW, S by E, SW by S.	·04
,, 15	29·683	56·0	52·7	·89	·409	68·1	58·8	9·3	7, 10, 10	S, WNW, W.	·00
,, 16	30·034	51·3	42·8	·75	·291	57·3	46·5	10·8	1, 2, 1	SW by W, SW by W, SW.	·05
,, 17	29·587	51·4	42·9	·75	·292	57·2	47·1	10·1	10, 2, 10	SSW, WNW, SW by W.	·10
,, 18	29·493	44·7	43·6	·96	.299	50·0	42·8	7·2	10, 10, 8	SSW, —, N by W.	·07
,, 19	...	...	...	...	...	57·0	36·4	20·6	...	... ...	·70
,, 20	29·344	43·9	37·4	·80	·241	49·9	43·8	6·1	7, 7, 4	SW, SW, WSW.	·63
,, 21	29·770	48·3	39·2	·73	·257	55·4	40·9	14·5	10, 2, 4	WSW, NW byW, SW byW.	·00
,, 22	29·385	53·6	51·1	·92	·387	59·5	45·5	14·0	10, 8, 5	SW, W, SW by W.	·16
,, 23	29·280	48·6	41·4	·78	·277	53·9	44·8	9·1	4, 8, 10	SW, SW, SW.	·01
,, 24	29·697	44·7	38·2	·80	·248	51·4	38·3	13·1	0, 2, 5	WSW, W, SSW.	·01
,, 25	29·891	48·2	42·2	·81	·285	53·2	33·1	20·1	4, 10, 10	SW, SW, SSW.	·00
,, 26	...	...	...	...	...	55·3	45·4	9·9	...	... ...	·11
,, 27	29·901	51·0	47·1	·88	·338	55·4	40·2	15·2	10, 10, 6	SW by S, SSW, SW.	·00
,, 28	29·799	45·4	41·9	·89	·282	49·3	47·9	1·4	10, 10, 10	N by W, NW, N.	·03
,, 29	29·932	42·8	38·2	·85	·248	48·0	41·4	6·6	10, 8, 7	NNW, —, —.	·08
,, 30	29·836	41·4	37·7	·88	·244	50·0	27·0	23·0	10, 6, 4	—, ESE, E.	·00
,, 31	29·727	49·5	48·9	·98	·359	52·9	33·0	19·9	10, 10, 9	ESE, E, ESE.	·01
Monthly Means.	29·872	52·1	47·4	·85	·350	...	...	12·4	...	...	3·21

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch. This remar applicable also to the Mean Daily Readings of the Barometer from January to September, 1862.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—Oct. 1862.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
A. M. 12	9	16	11	6	11	6	3	16	10	10	10	4	12	14	18	7	11	14	5	21	22	14	15	9	5	23	7	23	2	1	7	11·0
1	4	18	10	8	10	6	6	17	12	9	11	4	13	14	12	9	12	14	6	15	18	14	19	8	3	31	10	17	1	2	10	11·1
2	4	14	12	7	8	5	12	14	14	7	10	2	15	15	13	9	15	11	8	)	17	14	18	7	3	28	7	21	1	1	8	10·7
3	2	11	9	4	9	4	9	13	12	4	7	4	12	16	17	11	20	11	8		16	15	19	8	5	28	8	16	2	1	9	10·3
4	3	12	8	5	7	6	9	13	12	3	6	7	12	18	20	12	25	15	9		14	)	21	7	4	25	3	22	2	0	13	10·8
5	5	12	8	3	6	4	4	13	10	4	5	11	9	15	16	11	26	12	7		13		21	5	5	22	14	14	2	1	12	10·0
6	6	13	9	4	5	3	7	17	13	2	6	11	10	10	13	9	27	10	6	106	15		20	5	5	17	16	7	0	2	9	9·6
7	5	13	10	1	6	2	8	15	13	2	6	13	12	10	14	9	30	10	9		12	190	23	5	5	20	17	2	3	1	10	9·9
8	9	15	9	1	6	1	13	10	17	5	4	15	10	13	10	10	35	12	8		15		27	6	4	21	23	3	1	1	12	10·9
9	10	17	10	1	5	5	16	12	20	3	5	15	10	16	15	11	30	9	12		16		26	8	11	12	22	3	3	1	7	11·4
10	12	18	11	2	8	8	18	11	25	10	3	16	13	13	15	13	25	8	16	18	20	31	32	9	17	11	21	3	3	3	7	13·5
11	11	17	12	4	11	8	15	12	26	13	11	20	14	12	15	17	18	6	18	19	22	29	37	12	17	9	26	2	3	4	8	14·5
P. M. 12	11	16	14	5	12	7	16	12	29	12	14	24	19	13	15	15	20	6	19	23	23	30	33	12	13	14	26	2	5	2	8	15·2
1	10	18	13	6	12	7	18	13	28	8	12	21	15	20	12	15	14	5	17	21	25	25	33	11	21	13	27	3	5	4	7	14·8
2	11	17	11	2	18	2	14	12	25	7	8	28	16	16	14	14	20	3	14	21	21	21	29	11	22	13	25	5	4	5	6	14·0
3	8	13	12	2	19	5	17	11	20	6	10	26	16	19	12	9	16	9	16	19	15	20	27	12	21	13	20	5	2	5	8	13·3
4	8	13	10	1	15	5	12	10	20	10	12	25	13	14	8	9	17	15	15	16	10	19	23	3	23	7	26	2	0	5	5	12·0
5	7	8	9	0	11	4	21	11	20	9	10	28	10	8	4	5	15	11	22	13	7	16	18	6	26	7	20	3	1	12	5	11·2
6	10	11	8	1	14	5	21	11	24	10	11	19	13	4	5	7	17	7	26	13	8	19	17	6	26	7	24	4	0	11	7	11·8
7	10	10	6	1	11	3	18	15	16	12	9	15	8	15	5	9	15	7	32	14	8	15	16	5	27	6	27	2	1	8	6	11·4
8	9	7	6	1	12	3	19	12	18	6	9	12	9	14	7	9	18	9	36	11	9	16	14	4	26	9	28	3	1	7	4	11·2
9	8	7	8	1	15	4	22	9	13	7	6	13	12	15	6	11	15	7	37	14	7	15	12	6	28	6	23	4	0	7	3	11·0
10	11	11	7	2	10	6	19	10	8	14	5	15	11	19	7	10	13	10	38	18	7	14	13	5	28	8	27	5	1	6	3	11·6
11	11	10	7	10	6	4	16	10	11	10	4	13	10	16	7	11	13	9	22	18	14	16	10	5	23	8	25	3	1	7	2	10·7
12																																
Total Daily Movement.	194	317	230	78	247	113	333	299	416	183	194	361	294	339	280	250	467	230	406	380	354	533	523	175	368	358	472	174	44	97	176	11·9

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1862. Day of Month.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		Rain—read at 9·30 A.M.
	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Calculated. Relative Humidity.	Calculated. Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°			inches.
Nov. 1	29·883	50·0	49·4	·98	·366	53·7	46·9	6·8	10, 10, 10	N, —, —.	·000
,, 2	...	...	...	...	...	53·7	49·0	4·7	...	... ...	·000
,, 3	30·061	49·9	47·9	·93	·347	55·3	39·7	15·6	10, 10, 3	WNW, S by E, SSE.	·000
,, 4	30·029	50·8	48·6	·93	·356	55·8	35·1	20·7	9, 9, 9	SSE, SSE, SSW.	·007
,, 5	30·061	44·8	45·1	1·00	·315	47·4	45·0	2·4	10, 10, 10	N, —, W by S.	·438
,, 6	30·119	38·1	39·0	1·00	·255	42·9	33·7	9·2	10, 10, 10	—, —, NE.	·105
,, 7	30·290	37·3	37·3	1·00	·240	41·0	34·9	6·1	10, 10, 10	NNW, NW by W, N by W.	·130
,, 8	30·258	39·9	37·5	·92	·242	46.0	28·4	17·6	8, 8, 10	SW, SW, SW by S.	·005
,, 9	...	...	...	...	...	52·3	35·4	16·9	...	... ...	·015
,, 10	29·394	39·3	36·1	·89	·230	46·7	39·5	7·2	7, 8, 1	SW by W, SW by S, SW by S.	·090
,, 11	29·558	35·7	30·6	·84	·189	41·9	26·2	15·7	3, 1, 1	SW by W, NNW, NW.	·040
,, 12	30·018	37·4	28·2	·72	·174	42·4	25·6	16·8	1, 0, 0	SSW, NNW, NNW.	·000
,, 13	30·051	32·2	31·6	·98	·196	39·3	24·1	15·2	10, 4, 6	SSW, —, —.	·000
,, 14	29·929	33·7	33·9	1·00	·213	37·3	22·5	14·8	10, 10, 10	N by E, NNW, NNW.	·000
,, 15	30·078	39·9	37·9	·93	·245	44·4	30·8	13·6	3, 10, 10	NNW, N, N by W.	·008
,, 16	...	...	...	...	...	45·7	37·7	8·0	...	... ...	·000
,, 17	30·386	40·6	36·2	.86	·231	45·3	35·6	9·7	0, 1, 1	N, NE by N, N by E.	·006
,, 18	30·315	39·3	33·4	·81	·209	43·7	33·2	10·5	10, 10, 10	NE, NE, NE by N.	·000
,, 19	30·151	38·0	27·0	·68	·167	41·2	37·5	3·7	10, 10, 10	NE, ENE, NE.	·000
,, 20	30·183	37·6	30·3	·77	·187	40·8	33·2	7·6	3, 10, 10	ENE, NE by N, NE by N.	.000
,, 21	30·155	37·5	37·2	·99	·239	40·8	34·3	6·5	10, 10, 10	WNW, WNW, N by W.	·000
,, 22	29·892	34·8	27·8	·78	·171	40·3	28·1	12·2	7, 4, 6	NW by N, N, NNW.	·010
,, 23	...	...	...	...	...	38·8	23·0	15·8	...	... ...	.000
,, 24	29·759	35·6	30·0	·82	·185	41·0	25·3	15·7	8, 1, 1	NE by E, NE by N, NNE.	·000
,, 25	29·670	36·4	31·7	·85	·197	39.7	32·6	7·1	7, 8, 5	NE by N, NE by N, NE.	·000
,, 26	29·546	37·8	36·4	·95	·233	42·9	36·0	6·9	10, 10, 10	NW by N, NW by N, WNW.	·000
,, 27	29·572	41·3	38·6	·91	·252	46·7	28·2	18·5	10, 3, 3	WNW, WSW, SW.	·058
,, 28	29·777	41·6	40·1	·95	·265	49·6	30·6	19·0	3, 9, 10	S, S, SSE.	·003
,, 29	29·642	38·5	35·2	·89	·223	41·0	37·7	3·3	10, 10, 10	E by S, S by W, SSW.	·000
,, 30	...	...	...	...	...	42·7	31·5	11·2	...	... ...	·000
Monthly Means.	29·951	39·5	36·3	·90	·237	...	...	11·3	...	... ...	0·915

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—Nov. 1862.

Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Hourly Means.
12	3	2	2	3	3	3	5	3	15	11	6	2	5	1	3	12	12	6	9	13	4	4	3	5	16	18				3	6·4
A.M. 1	5	2	4	1	10	3	7	4	15	11	4	5	4	1	2	16	15	5	13	16	3	6	4	4	17	17				2	7·3
2	4	2	3	3	8	3	3	2	17	11	5	4	3	2	3	15	13	3	12	11	3	6	3	4	17	14				1	6·5
3	5	0	4	4	7	2	4	2	19	10	3	3	3	2	5	17	11	4	15	12	3	6	4	7	18	15				2	6·9
4	4	2	4	4	8	0	8	1	20	12	5	4	1	3	9	16	11	8	12	17	4	11	5	8	20	14	158	128	332	1	7·9
5	4	1	2	4	6	1	3	1	18	12	1	2	2	1	10	15	11	7	15	16	6	8	4	7	19	15				1	7·1
6	4	2	3	3	4	4	2	2	20	16	2	3	2	2	10	14	12	4	13	16	2	5	1	7	23	17				2	7·2
7	4	2	5	4	2	1	3	4	25	17	1	2	2	1	11	15	13	6	14	17	3	5	4	3	22	13				3	7·5
8	5	3	1	5	3	4	4	5	25	14	1	4	1	0	7	15	15	3	17	19	3	5	2	3	25	14				4	7·7
9	10	2	1	3	7	4	4	4	28	18	1	3	1	2	8	15	15	7	19	20	1	4	3	7	25	16				4	8·6
10	5	2	3	8	2	2	7	5	31	15	3	4	1	1	15	16	14	14	20	20	4	5	2	13	22				7	2	9·0
11	3	4	5	11	1	4	8	5	25	18	4	6	4	2	15	17	16	14	21	29	3	10	2	15	28				5	3	10·3
12	3	4	6	10	4	3	6	5	27	15	6	9	1	1	15	16	17	13	22	28	5	10	3	16	25				4	2	10·2
P.M. 1	1	5	9	8	2	2	5	6	33	16	8	12	0	1	17	15	16	17	22	19	6	11	6	16	25				3	2	10·5
2	1	2	7	7	1	2	7	5	26	14	8	9	1	2	18	9	13	15	20	14	2	9	3	15	24				3	3	8·9
3	6	3	9	6	2	4	6	9	20	10	5	7	3	3	18	5	10	12	18	13	5	8	1	15	20				4	1	8·3
4	3	1	11	5	3	8	5	8	13	9	2	8	1	2	20	5	9	8	18	12	6	4	1	13	17				1	3	7·3
5	2	3	7	5	4	4	1	7	6	9	1	5	1	3	15	5	11	9	19	11	4	6	4	10	17				2	2	6·4
6	1	2	3	5	4	8	3	5	7	8	2	3	1	3	15	6	14	12	15	12	4	4	4	10	23				5	4	6·8
7	1	2	3	3	4	9	2	9	10	9	3	5	1	2	17	4	9	12	15	8	2	7	7	10	24				3	1	6·7
8	1	0	1	3	2	6	3	11	8	10	3	3	1	1	15	8	11	11	14	7	3	2	4	13	20				2	2	6·1
9	1	1	6	1	1	5	3	15	8	7	2	3	2	2	15	10	8	13	11	3	4	4	4	12	25				2	2	6·3
10	2	2	3	1	3	8	3	10	8	7	3	2	2	3	13	9	9	11	15	4	3	3	2	15	21				2	3	6·2
11	2	1	1	2	3	5	4	13	11	8	3	3	1	4	12	11	3	9	13	3	2	4	2	15	19				4	7	6·1
12																															
Total Daily Movement.	80	50	103	109	94	95	106	141	435	287	82	111	44	45	288	286	288	223	382	340	85	147	78	243	512		818			60	7·7

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1862. Day of Month.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M.; 2 P.M.; and 5 P.M. respectively.		Rain-read a 9·30 A.M.
	Barometer, corrected to Temp. 32°*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9.30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°			inches
Dec. 1	29·602	43·0	41·5	·95	·278	44·9	35·6	9·3	10, 10, 9	E, E, E.	·046
„ 2	29·567	41·7	38·0	·88	·246	46·3	35·1	11·2	3, 7, 9	ENE, ESE, E.	·010
„ 3	29·682	45·5	41·7	·88	·280	48·5	39·2	9·3	5, 9, 9	SE, E by S, E.	·000
„ 4	29·839	46·6	45·6	·97	·321	48·7	43·3	5·4	10, 10, 10	E by N, E by S, SE by S.	·047
„ 5	29·986	49·4	47·5	·93	·343	51·9	44·2	7·7	4, 10, 10	S by E, S by E, S by E.	·008
„ 6	29·910	52·9	51·7	·96	·395	55·1	48·8	6·3	10, 10, 10	S by W, SSW, SSW.	·052
„ 7	...	...	...	...	...	54·4	47·0	7·4	...	...	·180
„ 8	30·086	42·2	31·7	·69	·197	43·9	40·8	3·1	1, 0, 0	WNW, W, W.	·164
„ 9	30·039	43·7	41·0	·91	·274	46·7	38·5	8·2	10, 10, 10	SW, SW, S by W.	·003
„ 10	29·793	48·5	41·8	·79	·281	52·9	41·5	11·4	3, 1, 0	W, W by S, W.	·328
„ 11	29·863	45·9	42·7	·89	·290	49·0	33·7	15·3	5, 10, 10	SSW, SSW, SW.	·010
„ 12	30·299	38·7	33·1	·82	·207	44·8	34·1	10·7	1, 8, 7	SW, WSW, SW.	·160
„ 13	29·969	44·4	43·3	·96	·296	46·8	33·8	13·0	10, 9, 1	SW, SW by W, W by S.	·033
„ 14	...	...	...	...	...	43·3	29·9	13·4	...	...	·090
„ 15	30·377	40·0	35·9	·87	·229	42·9	27·1	15·8	10, 9, 8	S by E, S by W, S by W.	·000
„ 16	30·336	42·5	39·6	·90	·260	44·4	34·1	10·3	10, 10, 10	SW, SW, SSW.	·000
„ 17	30·278	45·6	43·6	·93	·299	51·2	40·1	11·1	10, 10, 10	SW, N by W, NW.	·000
„ 18	30·189	43·5	42·0	·95	·283	45·4	31·7	13·7	10, 10, 10	SW, SW, SSW.	·090
„ 19	29·765	46·7	38·1	·74	·247	49·1	41·1	8·0	7, 8, 6	WNW, W, W by S.	·030
„ 20	29·560	41·4	30·8	·69	·191	43·7	37·2	6·5	2, 10, 10	SW by W, NW by W, NW by W	·000
„ 21	...	...	...	...	...	41·5	35·5	6·0	...	...	·000
„ 22	30·164	36·2	31·6	·85	·196	38·6	34·0	4·6	8, 10, 10	NNW, NW by W, NW by W.	·000
„ 23	30·086	43·3	42·7	·98	·290	45·9	34·0	11·9	10, 10, 10	SW, SW by S, N.	·122
„ 24	30·255	43·1	40·6	·92	·270	45·3	33·9	11·4	10, 10, 10	SW, WSW, SW.	·008
„ 25	...	...	...	...	...	49·4	41·9	7·5	...	...	·003
„ 26	30·296	46·8	39·5	·78	·260	49·0	38·8	10·2	10, 10, 10	WSW, W, SW by W.	·000
„ 27	30·365	45·4	44·1	·96	·305	49·9	36·8	13·1	10, 8, 10	——, SW, SW.	·000
„ 28	...	...	...	...	...	50·4	39·1	11·3	...	...	·000
„ 29	29·482	46·8	43·9	·90	·303	49·2	45·1	4·1	10, 8, 10	S by W, SW by S, WSW.	·020
„ 30	29·515	41·3	37·2	·87	·239	45·3	37·1	8·2	1, 4, 7	SW by W, W by S, W by N.	·165
„ 31	30·162	38·7	35·3	·89	·224	44·6	32·8	11·8	0, 3, 10	SW, WSW, SW by S.	·008
Monthly Means.	29·979	44·0	40·2	·88	·269	...	...	9·6	...	...	1·577

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER—DEC. 1862.

Hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
12	8	15	11	9	6		14	9	12	12	6	10	9	4	2	4	15	5	27	25	22	26	10	3	12	18	9	20	19	12	10	12·1
A.M. 1	5	12	11	12	4		17	12	10	14	7	10	14	5	4	7	17	6	28	25	23	22	7	4	14	18	7	17	19	10	12	12·4
2	4	14	9	14	3		21	10	9	16	7	8	13	3	1	5	21	6	27	28	22	18	8	3	14	18	3	18	19	6	10	11·9
3	3	11	12	11	5		20	11	8	17	3	8	17	6	2	8	18	5	28	30	20	19	7	3	13	20	3	17	22	6	5	11·9
4	8	15	10	10	6	435	19	14	10	20	2	11	20	5	7	5	18	8	27	32	22	16	7	4	10	20	7	17	23	8	8	13·0
5	8	13	13	9	5		18	15	11	20	5	7	24	4	6	5	19	7	32	27	20	15	4	5	9	20	4	17	22	5	5	12·5
6	9	13	16	7	6		13	16	8	15	4	8	27	5	5	7	24	8	31	31	21	12	2	3	13	19	6	19	25	6	5	12·8
7	8	15	16	8	8		12	20	6	13	9	8	29	5	7	8	26	8	28	29	22	10	4	3	10	24	4	15	30	6	7	13·3
8	10	14	18	11	11		12	19	9	14	12	5	25	5	5	5	21	9	25	25	25	8	2	4	7	20	3	16	29	5	7	12·7
9	17	19	18	10	17		18	12	9	21	12	5	23	5	5	7	21	9	27	25	26	13	3	6	8	21	1	17	28	4	8	13·8
10	17	18	19	11			18		9	20	18	3	22	5	4	16	20	12	25	25	30	17	3	5	6	22	2	21	23	8	7	14·5
11	14	17	16	8			14		12	20	17	7	23	7	7	12	20	13	27	30	30	13	5	5	12	21	6	20	18	10	8	14·7
12	17	15	18	8			15	98	13	21	13	10	22	7	12	10	18	17	28	32	30	12	4	6	14	24	9	23	24	11	9	15·8
P.M. 1	21	12	17	7		198	12		13	19	14	10	18	8	12	9	16	17	22	31	32	11	5	7	13	25	9	21	25	13	9	15·3
2	21	9	18	7			13		13	15	16	8	5	8	12	7	11	21	23	28	33	9	5	7	9	16	11	16	23	12	9	13·8
3	16	7	22	6			9	12	8	11	16	6	8	5	11	9	7	18	24	28	29	10	6	7	9	15	10	14	22	12	6	12·5
4	21	9	20	7			12	16	9	7	12	6	6	3	7	10	6	21	21	24	26	8	5	7	9	11	12	17	15	12	7	11·9
5	13	5	17	3		26	11	7	9	5	7	7	7	2	5	12	8	17	19	20	25	6	4	9	12	16	13	22	13	10	8	11·3
6	12	10	17	5		21	13	14	11	7	4	6	9	3	5	11	7	16	18	19	27	5	4	10	9	17	15	20	13	10	12	11·7
7	13	10	16	6		20	10	16	18	8	2	5	5	2	5	12	4	17	23	22	29	6	3	12	8	13	11	14	14	10	16	11·7
8	15	10	15	3		17	10	13	18	10	4	5	8	2	6	14	5	20	19	21	25	8	4	15	8	14	16	13	13	10	14	11·8
9	15	6	10	3		16	10	12	20	5	7	5	7	2	4	14	4	23	21	25	26	7	3	13	9	11	16	14	7	13	10	11·3
10	13	11	11	6		18	8	14	20	5	9	10	10	1	6	15	4	25	24	27	25	6	4	14	17	12	19	16	12	15	15	13·1
11	13	7	9	4		15	4	12	13	7	11	9	3	1	6	14	5	23	23	21	22	9	5	13	13	9	18	16	13	15	15	11·6
12																																
Total Daily Movement.	301	287	359	185		837	323	352	278	322	217	177	354	103	146	226	335	331	597	630	612	286	114	168	258	424	214	420	471	229	222	13·1

TABLE SHOWING THE MEAN VELOCITY OF THE WIND FOR EACH HOUR OF THE DAY IN THE DIFFERENT MONTHS OF THE YEAR 1862 (IN MILES PER HOUR).

	A. M.												P. M.											
Hour.	12 to 1	to 2	to 3	to 4	to 5	to 6	to 7	to 8	to 9	to 10	to 11	to 12	to 1	to 2	to 3	to 4	to 5	to 6	to 7	to 8	to 9	to 10	to 11	to 12	Mean.
Jan. ...	10·8	11·1	11·4	11·2	11·5	11·0	11·1	10·8	11·2	12·0	12·2	13·6	14·7	14·1	12·9	12·1	11·3	10·4	10·9	11·0	10·5	10·7	11·3	10·5	11·5
Feb. ...	11·8	11·7	13·1	12 2	13·0	12·1	11·9	11·8	13·3	14·8	15·3	16·4	17·2	16·1	16·1	15·7	14·5	12·2	12·3	12·4	11·3	11·5	12·7	10·4	13.1
March	10·4	9 6	9·8	10 3	9·6	9·0	9·6	10·9	11·7	12·2	13.7	14·0	13·2	13·5	14·2	14·5	14·3	12·8	13·7	13·5	12·8	12·3	11·5	9·8	12·1
April	9·1	9 0	8·2	8 5	8·9	9·2	10·4	12·8	13·6	14·6	15·3	16 8	16·8	17·3	17·1	16·5	16·5	14·7	12·8	12·3	11·5	11·0	11·2	10·1	12·7
May ...	8·4	7·5	7·7	7·9	8·5	7·4	9·4	11·0	11·2	11·7	11·2	12·5	12·8	13·2	13·2	13·0	13·4	12·4	11·5	10·0	9·3	9·6	9·5	8·3	9·7
June...	7·8	8·5	8·0	7·5	8·2	9·1	10·1	11·7	13·1	12·9	13·9	14·3	14·8	14·6	14·7	14·4	14·0	12·2	11·5	10·0	9·0	8·7	9·7	7·9	11·1
July ...	8·1	7·8	8·0	8·8	8·9	9·1	11·0	12·6	13·4	13·1	14·4	14·9	15·7	15·7	15·5	14·6	14·4	12·5	11·5	9·7	8·8	8·3	9·2	7·9	11·1
August	6·0	5·7	5·7	5.4	5·6	5·9	6·9	8·8	9·9	10·5	10 7	11·1	12·2	12·1	11·8	11·5	11·2	9·5	8 0	7·8	7·3	7·0	6·5	5·9	8·5
Sept. .	5·7	6·1	5·3	5 7	5·9	5·9	6·3	7·7	9·5	10·6	12 1	12·4	11·9	12·2	11·8	11·3	10·9	9·6	8·5	7·8	7·6	7·0	7·0	6·0	8·5
Oct. ...	11·0	11·1	10·7	10·3	10·8	10·0	9 6	9·9	10 9	11·4	13·5	14·5	15·2	14·8	14·0	13·3	12·0	11·2	11·8	11·4	11 2	11·0	11·6	10·7	11.9
Nov....	6·4	7·3	6·5	6·9	7·9	7·1	7·2	7·5	7·7	8·6	9·0	10·3	10·2	10·5	8·9	8·3	7·3	6·4	6·8	6·7	6·1	6·3	6·2	6·1	7·7
Dec ...	12·1	12.4	11·9	11·9	13·0	12·5	12·8	13·3	12·7	13·8	14·5	14·7	15·8	15·3	13·8	12·5	11·9	11·3	11·7	11·7	11·8	11·3	13·1	11·6	13·1
Mean	9·0	9·0	8·9	8·9	9·3	9·0	9·7	10·7	11·5	12·2	13·0	13·8	14·2	14·1	13·7	13·1	12·6	11·3	10·9	10·4	9·8	9·6	10·0	8·8	10·9

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

MONTHLY AND ANNUAL MEANS FOR THE YEAR 1862.

Month.	Barometer, corrected to Temp. 32.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Daily Range.	Total Fall of Rain.	Month.	Barometer, corrected to Temp. 32.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Daily Range.	Total Fall of Rain.
	inches.	°	°		inch.	°	inches.		inches.	°	°		inch.	°	inches.
January	29·810	39·7	36·8	.87	·240	9·1	1 637	August ...	29·905	59·4	51·1	·76	·389	15·8	2·692
February.....	30·027	41·2	36 3	·84	·240	7·3	0·411	September	29 994	57·1	50·5	·81	·384	14·7	2·597
March	29·638	43·2	39·4	·88	·269	10·3	4·472	October .	29·872	52·1	47·4	·85	·350	12·4	3·215
April	29 980	47·5	40·5	·80	·278	12·7	2·575	November.	29 951	39·5	36·3	·90	·237	11·3	0·915
May.....	29·854	53·9	47·5	·82	349	15 1	3·775	December.	29·979	44·0	40·2	·88	·269	9·6	1·577
June	29·850	53·5	46 7	·80	·336	15·1	2·366								
July	29·907	58·3	50·1	·77	·378	15·8	2·057	Mean	29·900	49·1	43·6	·83	·310	12·4	28·289

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

URANUS.—DOUBLE STARS.—OCCULTATIONS.

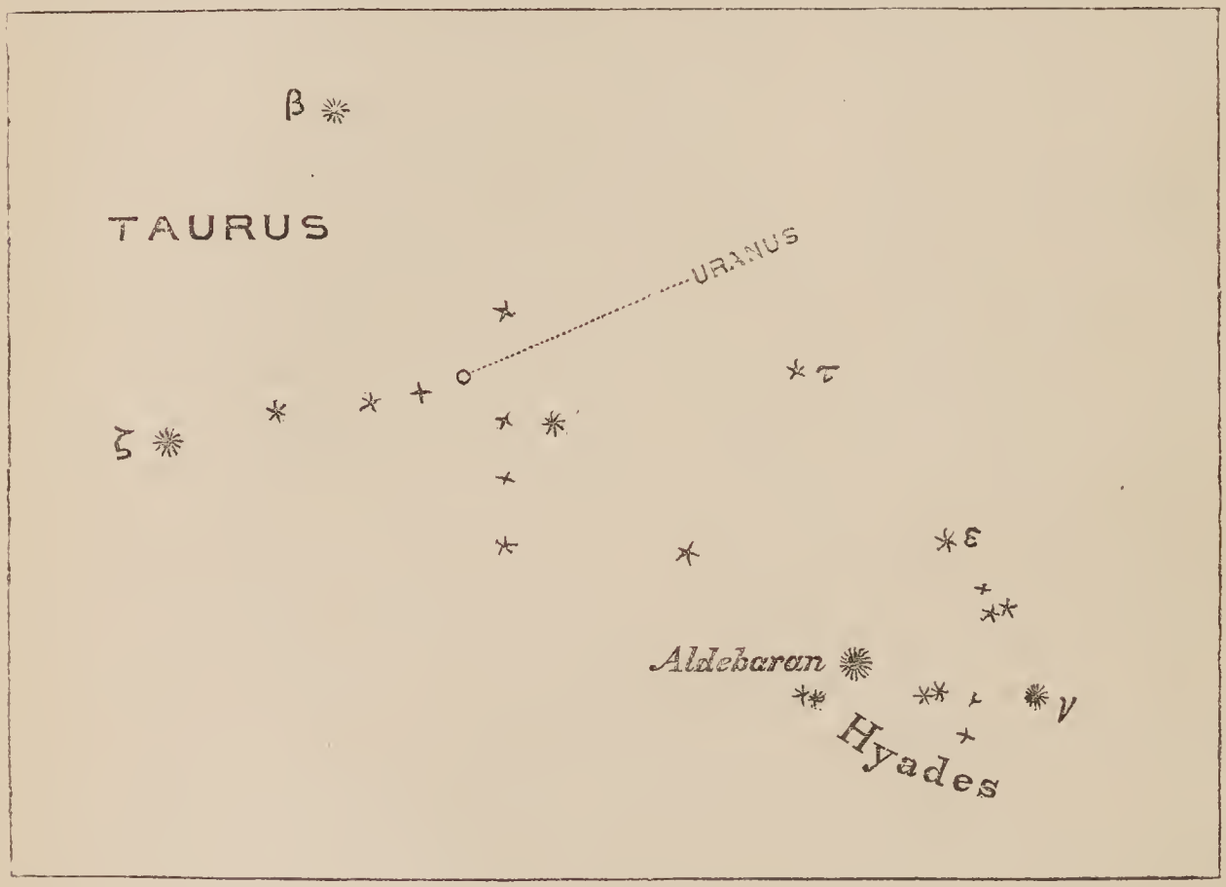
BY THE REV. T. W. WEBB, F.R.A.S.

URANUS.

A VERY minute lucid speck, barely distinguishable in the dark midnight, is the only indication of the presence of what may be fairly deemed one of the most important members of our system —a magnificent globe, nearly four and a-half times the diameter of the earth, and attended by a numerous retinue of satellites. Such is the result of its amazing distance, 1646 millions of miles at its nearest approach in *perihelio* and opposition; and hence, as a popular object, it has never attracted much attention. Eighty-two years are nearly completed since it has been recognized as a planet (for as a fixed star it had been observed by Flamsteed in 1690, if not by Tycho Brahe as far back as 1587); and yet to many possessors of telescopes quite competent to show it fairly, it is wholly unknown. It must indeed be admitted that there is not much to be made of it with ordinary optical means; but still the earnest student will not be satisfied with its omission, nor would he wish to lose the opportunity thus afforded him of gaining a fresh idea of the stupendous magnitude of the solar system, so impressively indicated by the diminutive aspect of this majestic planet. Under favourable circumstances it is perceptible with the naked eye; Smyth tells us that it appears as a star of the 6th or even 5th magnitude; I have seen it quite distinctly as a very minute but sharp and steady point; and it is of course sufficiently conspicuous even in the most ordinary telescope. I have not made the trial what amount of aperture would suffice to exhibit it as a planetary disc; but since its apparent diameter never varies much from 4″, no very small instruments can be expected to reach it; yet even in these there may be a possibility of recognizing it by its steady and quiet light, very dissimilar to the sparkling and vivid aspect of a star of corresponding magnitude. Sir W. Herschel discovered its visible disc in 1781 while using a power of 227 applied to a 7 feet reflector with a 6·3 inch speculum; but a much smaller magnifier is capable of showing it, especially to those who know what to expect; for, according to a remark of his own, "when an object is once discovered by a superior power, an inferior one will suffice to see it afterwards." With a $3\frac{7}{10}$ inch object-glass I found the disc perceptible with a power of 144, and much dilated with 250; my present $5\frac{1}{2}$ inch achromatic just shows it with 55, and defines it very fairly with 170, and even 460. Once I had the pleasure of seeing it as a beautiful miniature full moon, with an 11 feet achroma-

tic of 7 inches aperture, considered the *chef-d'œuvre* of the late George Dollond, at that time the property of H. Lawson, Esq., of Bath, and subsequently bequeathed by him to the Greenwich Naval School.

During the present season Uranus will be found a little beneath a line joining Aldebaran and β Tauri, about one-third of the distance from the latter star, the position of which is specified in our list of Double Stars, No. 74. For the convenience of the student a diagram is subjoined, which, with



little pretension to accuracy, may prove of use in the search. Excepting Aldebaran and the Hyades, and β and ζ Tauri, the stars are barely visible to the naked eye, and unfortunately not dissimilar in magnitude to the planet; a tolerably high power should therefore be used in looking for it, sufficient to identify it by "raising" an obvious disc at first sight.

DOUBLE STARS.

During the last and the present month our evening skies develope their greatest brilliancy. Orion, the matchless Orion, in his golden armour,* illuminates the meridian; Sirius, the magnificent leader of the starry host, blazes out a little below him to the left, with his attendants in Canis Major towards the S. horizon; the beautiful clusters of Taurus are only beginning to decline towards the W.; on the other side of the meridian are the heads of the Twins, a conspicuous pair; while Capella,

* Armatumque auro circumspicit Oriona.—Virgil.

the rival of Wega, and to some eyes its superior, occupies the region of the zenith. We should wait in vain for a more perfect combination of stellar beauty and grandeur.

The *Pleiades* surely will require no guide. This beautiful group in which, notwithstanding the ancient idea of a "lost Pleiad," some eyes still descry a seventh star* (though mine will not), is so generally known that it can scarcely be necessary to point it out somewhat W. of the meridian about 7h. at the beginning of the month. The principal star, *Alcyone*, also known as *η Tauri*, was brought into considerable notice, some years ago, by a speculation of Mädler, that it was the "central sun," or, more correctly speaking, was the nearest luminous body to the common centre of gravity, about which the visible universe is slowly revolving; the idea, however, seems to be now abandoned, as having been based on inadequate data. Novices often express a wish to look at the Pleiades through a telescope; but notwithstanding their promise to the unaided eye, they prove a disappointing picture as a group, lying too widely scattered for the compass of any ordinary field; in detail, however, they contain some pleasing and remarkable combinations, especially a beautiful little triangle close to Alcyone; a neat pair at some distance from this object *n.p.* may also be mentioned, and a curious crooked row of small stars *s.* of the *lucida*. Their neighbours the *Hyades* contain several attractions for the student. These are easily recognized, lying a little to the left of the Pleiades, and somewhat beneath them, in the form of a flight of wild-geese, or of the letter V turned upon its side with its point to the west; this is occupied by the star *γ Tauri*, 3 mag.; at the E. end of the lower stroke of the letter stands *α Tauri*, a conspicuous red star; at the corresponding termination of the upper stroke is *ε*. Our list begins with the ruddy star—

70. *α Tauri, Aldebaran.* 1′ 47″·9. 35°·9. 1 and 12. Pale rose tint and sky-blue. The magnitude of the attendant has been assigned by Smyth on deliberate comparison: he saw it, however, readily with $3\frac{3}{4}$ inches of aperture, as Dawes has done with an inch less; few astronomers, however, possess such an eye as the latter observer. I have seen it distinctly with $3\frac{7}{10}$ inches, but not without considerable attention; it is a good test of the instrument and the sight: in this respect resembling *Wega*, striking as is the dissimilarity of its hue. W. Struve has thought it not impossible, from traces of common spatial motion, that this may be a physically connected system; if so, the remarks on No. 25 of our list would be strikingly exemplified.

In the midst of the lower line of the V, the unaided eye

* Möstlin, the tutor of Kepler, is said by the latter to have seen fourteen stars there without a telescope. A valued correspondent of mine has perceived eight.

will readily detect a pair somewhat like *α Capricorni*, though of less magnitude. This is—

71. θ^1 and θ^2 *Tauri*. 5′ 36″·8. 166°·7. 5 and 5½. Pearly white and yellowish. A common proper motion is suspected; according to W. Struve, more than suspected: should this be verified, we behold here a glorious system, whose magnitude and wide separation seem sufficiently to bespeak its comparative nearness to our earth. It ought to show an appreciable parallax; but I am not aware that any attempts have been made to detect it; meanwhile, it is worthy of remark that, though a large spatial motion naturally introduces a suspicion of proximity, its absence is no indication to the contrary, as a great amount of displacement may be concealed by its direction relatively to our sight. These stars form a noble object in almost any telescope, especially if the field is large.

At no great distance is another grand pair, very similar in character, though not quite of equal magnitude; it will be found by a line from θ through ϵ; this points to a group of small stars, the nearest of which are—

72. κ^1 and κ^2 *Tauri*. Not in the Bedford Catalogue, but according to W. Struve's data, 5′ 39″·28. 5 and 6. Yellowish white and white. This double star is remarkable not only from its striking telescopic aspect, and its similarity to θ, but from the intervention of a very pretty minute pair, 10 or 11 mag., between the components; a curious copy, on a very reduced scale, of its mightier neighbours.

A third object of the same class is to be found, singularly enough, in the same neighbourhood, so near as to lead to the impression that something more than optical juxtaposition may probably be concerned in the arrangement, especially as other large pairs, wider than these three, occur within the compass of a few degrees. Immediately *s.f. Aldebaran*, we shall find—

73. σ^1 and σ^2 *Tauri*. Not catalogued by Smyth; 5·2 and 5·7 according to W. Struve's notation; but, like κ^1 and κ^2, much fainter than θ^1 and θ^2 to the naked eye. White.

A line through γ and ϵ, at an equal distance, falls upon

74. τ *Tauri*. 61″·6. 209°·8. 5 and 8. Bluish white and lilac; a pretty, though wide object.

A line from *Capella*, or *α Aurigæ*, now reigning supreme near the zenith, down to the three stars which almost every one recognizes as the *Belt of Orion*, will pass, before reaching the middle distance, a solitary 2 mag. star. This is *β Tauri*, the Bull's N. horn, the S. being marked by a less conspicuous star, ζ, 3 mag., 8° below it, a little to the left. A line from β to the *Pleiades* passes, nearly where crossed by another, through ϵ and κ *Tauri*, between two very minute stars, each worth examination. The uppermost is—

75. ϕ *Tauri.* 55″·9. 241°·8. 6 and 8½. Light red and cerulean blue. This will be found a striking contrast of colours.

The lowermost star is—

76. χ *Tauri.* 19″·3. 25°·1. 6 and 8. White and grey.

Between this and the group containing κ, is a pretty object, invisible to the naked eye, and therefore smaller than any that were considered eligible for this list; it is, however, so easily found with the telescope from its position, that I am induced to insert it:—

77. 62 *Tauri.* 28″·6. 290°. 7 and 8½. White and pale purple.

Our acquaintance with the *Hyades* has led us to linger in their neighbourhood; but we must return to catch some objects declining so rapidly to the west, that the earliest opportunity must be taken of looking for them.

If we continue the left side of the square of *Pegasus* downwards about half as far again, it will fall on a little group of inconsiderable stars; the preceding of these is—

78. 35 *Piscium.* 11″·9. 149°·5. 6 and 8. White and purplish.

Two lines, one from β *Andromedæ* (see No. 64) through the middle of the head of *Aries*, the other from *Capella* passing a little beneath the *Pleiades*, meet near a considerable 2 mag. star, the largest of its vicinity, α *Ceti*, *Menhab*, or *Menkar*, worth looking at for its beautiful orange hue, as well as the fine blue tint of a 5½ mag. star just *n.* of it. It lies in the jaw of the *Whale*, a huge constellation stretching far away to the S.W., its second star, β, being the brightest near the horizon in that direction. The next star, *p. a.* a little *s.*, is—

79. γ *Ceti.* 2″·6. 285°·7. 3 and 7. Pale yellow and lucid blue (I thought the small star tawny, 1850·9). A fine pair, and a good test for a small telescope. W. Struve gives it common proper motion.

The largest star near a line drawnfrom α through γ Ceti is—

80. α *Piscium.* 3″·8. 333°·4. 5 and 6. Greenish and pale blue. An orbital revolution appears to be demonstrated here. There seems to be something very peculiar in the colour of the smaller star, as to which observers are strangely at variance with each other, and even with themselves. Some see no contrast, some agree with Smyth, some find it tawny or ruddy. The details are curious, but too long for insertion here. Other small stars show a similar uncertainty, which, as it refers to complementary colours, may perhaps depend upon the condition of the retina. That real variations, however, do exist, was long ago suspected by Herschel II. and South, and is still supposed by Secchi.

Near a line from α *Piscium* to the large star β (*Deneb Kaitos*)

in the tail of *Cetus* (see No. 78), we shall find two 3 mag. stars, θ and η *Ceti*. A little way *p.* θ (the nearer of the two to α *Piscium*) is our next object, which ought to be looked for very early in the evening and in the month, or may perhaps, like some others in this list, have to be reserved for another season—

81. 37 *Ceti*. 50″·6. 332°·3. 6 and 7½. White and light blue. This fine pair, to which W. Struve ascribes common proper motion, is attended by a smaller and closer one, *n.*, a little *p.*, arranged in a not dissimilar way, its data being 20″·5. 341°·1. 8 and 10. Yellow and violet. The whole combination is a very pretty one, but requires the extended field of a low power.

Somewhat below the centre of a line from α *Piscium* to γ *Pegasi* we shall find a small 4 mag. star, ϵ *Piscium*. The next star visible to the naked eye *f.* this, is—

82. ζ *Piscium*. 23″·4. 63°·8. 6 and 8. White and greyish. Smyth says that the larger star may possibly be variable, 4 to 6 mag. W. Struve finds common spatial motion.

If we now join α *Andromedæ* and γ *Arietis* (No. 68) the line will pass a little above two small stars, lying nearly parallel to it. The one nearly under its centre is η *Andromedæ*, 5 mag.; the other, further *n. p.*, is ζ, 4 mag. (so rated in the S. D. U. K. Star Maps, though they differ little to the eye). Between ζ and η, but nearer η, is—

83. 36 *Andromedæ*. 1″ (1843·12). 322°·9. 6 and 7. Bright orange and yellow. The evident motion of this interesting pair has so widened it as to render it an excellent test for moderate-sized instruments. I was surprised at being able to elongate it with 144 of $3\frac{7}{10}$ inches, 1850·87; there is at present a strong black division with 170 of 5½ inches. George Knott, Esq., of Woodcroft, Cuckfield, to whom I am indebted for much valuable information, has recently obliged me by repeatedly measuring it with his 7⅓-inch Alvan Clark equatorial, and gives as his mean *approximate* result, to which, however, he does not attach great weight, 1″·246. The angle, also, according to Secchi in 1857, has been rapidly increasing.

A line from ζ through η *Andromedæ* points somewhat above a group of little stars; the nearest of these to η is—

84. ψ^1 *Piscium*. 30″·2. 160°·4. Both 5½. Flushed white and pale white. A third minute star lies *s. f.* from this noble object.

The 3 mag. star lying between α and β *Andromedæ*, a little below the line, is δ *Andromedæ*. If we join this star and η we shall find, a little to the left of the line in mid-distance—

85. 65 *Piscium*. 4″·5. 298°·5. 6 and 7. Both pale yellow. Smyth thinks this remarkably neat pair may be in slow orbital

motion, which, however, has not been confirmed by the recent observations of Secchi. Nor is the inequality of magnitude apparent. W. Struve made them both 6 mag., 1832·13, the *p.* star perhaps very slightly the smaller. I found them very nearly equal, 1850·01, 1855·85, 1862·89.

A line through γ and β *Trianguli* (see No. 69) carried almost twice as far again, points nearly to—

86. 56 *Andromedæ*. 2′ 56″·2. 302°·4. Both 6, and both yellow. The interest of this wide pair is derived from its common motion through space.

Between γ *Andromedæ* and γ *Trianguli*, one-third of the distance from the former, is a very minute star, having another somewhat brighter *s.* of it, in the line between γ *Andromedæ* and β *Trianguli*. The smaller star is—

87. 59 *Andromedæ*. 16″·3. 34°·7. 6 and 7½. Bluish white and pale violet. A fine stationary pair.

The lovely brilliant some way beneath the three stars in the Belt of Orion, and a little in advance, is *Rigel*, β *Orionis*, in the giant's foot. A line from this star to γ *Ceti* passes, in mid-distance, a small object, which must be searched for with the telescope, for want of means of identification; as, however, the neighbourhood is not rich in stars, it will not give much trouble. It is a very beautiful pair:—

88. 32 *Eridani*. 6″·6. 346°·5. 5 and 7. Bright yellow and flushed blue; in brilliant contrast. Secchi calls its colours "magnifici" and "superbi." No motion has been perceived in it.

We must now attack the most glorious of constellations, and one of the richest in remarkable objects of all kinds, beginning with the belt, as so generally known. The uppermost or leader of these three stars is—

89. δ *Orionis*. 53″·2. 359°·9. 2 and 7. Pale white and flushed white. A beautiful pair, very nearly on the equator, and therefore well calculated for measuring telescopic fields by its passage. The lowermost, or hindermost, is—

90. ζ *Orionis*. 2″·5. 148°·8. 3 and 6½. Yellow and flushed blue. This is a well-known and excellent test, more severe, in consequence of the magnitude of the large star, than is indicated by its mere distance. I have just divided it with 80 and a $3\frac{7}{10}$-inch aperture. It is very strange that the lynx eye of Herschel I. should have overlooked the small star, which was reserved for Kunowsky about 1821. It is either stationary, or, as Secchi thinks, in very slow angular motion. A third 10 mag. star lies at 56″ and 7°·8. I have seen the *comites* of this and the last object oscillate like pendulums, as described under No. 65. Just beneath ζ, a little *p.*, is—

91. σ *Orionis*, a multiple star, consisting of two groups of

four stars each, with two exceedingly minute, or, as Barlow very ambiguously called them, "*fine*," stars between them. It is, on this account, a good test for sight; all the stars have been seen, though one of the intermediate ones only by glimpses, with a $3\frac{7}{10}$-inch object-glass, by Cooke. The minute star *p.* the *lucida* was somehow missed by the two Herschels and South, and discovered by Dawes in 1829; yet it is now not a difficult object, being 11 mag. and 12″ distant from its 4 mag. neighbour; and it has been perceived with only $3\frac{1}{4}$ inches of aperture, so that there is some suspicion of variability.

Beneath the *belt* hangs the *sword* of *Orion*, a group of small stars with a brighter one at the bottom; this latter is—

92. *ι Orionis*. 11″·5. 141°·7. $3\frac{1}{2}$ and $8\frac{1}{2}$. White and pale blue; the smaller star perhaps variable. This beautiful pair has an 11 mag. companion at 48″·9 and 102°·8, and lies in a glorious low-power field, which contains a misty glow, indicating the presence of an outlying portion, as large instruments reveal to us, of the grand nebula. The Earl of Rosse's speculum, however, exhibits the triple group encompassed by a singular intervening patch of darkness. Just above this is—

93. *θ*[1] *Orionis*, a quadruple group, known as "the trapezium," and lying in the heart of one of the most wonderful and mysterious objects in the universe, the—

Great nebula of Orion. Of this our readers may expect, some future day, a more detailed account than our space will now admit. In the meantime let them try to accustom their eyes, as far as their telescopes will aid them, to its marvellous construction and extent. The quadruple group is shown to be physically connected, from its joint spatial motion; it contains two more very minute stars, which are admirable telescopic tests. The fifth, discovered by W. Struve, has been seen by Dawes with a 5-feet achromatic, and is sufficiently evident with my $5\frac{1}{2}$-inch aperture; the sixth is considerably fainter, a very trying criterion of excellence; it has been perceived, however, with one of Lassell's 9-inch specula. The colours of the four principal stars are given as pale white, faint lilac, garnet, and reddish.

94. *β Orionis, Rigel.* 9″·5. 199°·4. 1 and 9. Pale yellow and sapphire blue. The position of this splendid object has been described after No. 87. Smyth thought it merely optical, but Secchi finds movement. It has been long known as a test, but instruments even of moderate size have left it behind in modern days, and it has the disadvantage of being low. Dawes has seen it, as well as the companion of *Polaris*, with a 2-feet Dollond, aperture $1\frac{6}{10}$-inch, power 70.

The stars of the belt point *n. p.* at a few degrees distance to—

95. ρ^1 *Orionis.* 6″·8. 61°·8. 5 and 8½. Orange and smalt blue. Probably fixed. 1849·11, 1856·19, I thought the *comes* much smaller than its assigned magnitude.

The next star *s.* of γ, a very little *p.*, is—

96. 23 *Orionis.* 32″·3. 27°·9. 5 and 7. Creamy white and light blue. W. Struve makes them greenish white and white, a solitary instance of such a combination. *s. f.* from this, close at hand, lies ψ^3, and this is followed, slightly *n.*, by—

97. 33 *Orionis.* 2″. 25°·8. 6 and 8. White and pale blue. A beautiful pair.

In a line from Betelgeuse to 23 *Orionis,* 2° from the former, and just visible to the naked eye in a transparent night, we find—

98. 52 *Orionis.* 1″·8. 199°·9. 6 and 6½. Pale white and yellowish. Smyth calls this very neat pair stationary; but W. Struve gives it a common proper motion. It forms an excellent test, from its permanence in distance. I have seen it nicely divided with 144 of $3\frac{7}{10}$-inches.

Above the two shoulders of *Orion* is the *head,* a group of small stars; the uppermost of these is—

99. λ *Orionis.* 4″·5. 43°. 4 and 6. Pale yellow and purplish. Stationary. The field is very fine. $5\frac{1}{2}$ inches show me a very minute *comes* at a little distance, not in Smyth, but in Struve and Secchi.

We take one more object, as from its S. declination it will soon be lost. *s.* of *Rigel,* a very little *p.*, are two small stars, one beneath the other; the lowermost is—

100. κ *Leporis.* 3″·7. 359°·5. 5 and 9. Pale white and clear grey.

OCCULTATIONS.

During the present month there will be only two occultations of considerable stars by the moon at convenient hours. Feb. 6th, *e* Leonis, 5 mag., will be hidden at Greenwich from 9h. 9m. to 9h. 26m. Feb. 27th, 15 Geminorum, 6 mag., from 9h. 45m. to 11h. It will be better to insert here, for the convenience of some readers, one on March 1st, when 5 Cancri, 6 mag., will disappear at 5h. 41m. and emerge at 6h. 56m.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*Dec.* 17.

New Graptolites in the Skiddaw Slates.—Professor Harkness and Mr. J. W. Salter communicated a paper in which they stated that they had discovered several species of Graptolites new to the Skiddaw Slates in certain flaggy beds almost devoid of cleavage, which occur at intervals in the lower portion of the series, in several localities. The rocks are much more fossiliferous than has hitherto been supposed; and the evidence of the fossils clearly proves them to be of the same age as the Lower Llandeilo rocks of Wales and the Quebec Group of Canada. The thickness of the Skiddaw Slates was estimated at 7000 feet, and the total thickness from the base of the Skiddaw Slates to the Coniston limestone is 14,000 feet.

Besides several species of well-known Graptolites that are also found in the Lower Llandeilo rocks and in the Quebec Group (Taconic System), Mr. Salter has been enabled to identify *Phyllograpsus angustifolium*, Hall, *Tetragrapsus bryontodes*, Hall, and another species of that genus, *Dichograpsus Sedgwicki*. Also a new species, *Didymograpsus caduceus*, and some others. He has given the name of *Caryocaris Wrightii* to a Crustacean discovered in these rocks by Mr. Wright. Mr. Salter considers the Skiddaw Slates to be of the same age as the Quebec Group, the graptolitiferous rocks of Melbourne, and the Tremadoc Slates of Wales.

ROYAL SOCIETY.—*Jan.* 8.

On the Immunity of the Stomach from being Digested.—The fact that the stomach resists during life the action of its own gastric fluid, but that it is readily dissolved by it after death, should that event occur during the process of digestion, is one well known to physiologists.

John Hunter attributed this immunity to the protecting agency of the living principle; but it has been shown, by direct experiment, that the tissues of living animals are dissolved when introduced into the stomach. At present the prevailing idea is that the mucous lining serves as a protection, by being constantly renewed during life.

Dr. Pavy's paper contained a description of some experiments disproving this view, inasmuch as he found that the mucous membrane might be entirely removed from a portion of the stomach, and that food could afterwards be digested without the abraded surface of the stomach presenting the least evidence of having been attacked.

Dr. Pavy suggested that the protection of the stomach was due to chemical principles; inasmuch as the acidity, which is an essential characteristic of the gastric juice, would be prevented acting on the

living tissues by the current of alkaline blood which is always circulating during life; but that after death, the blood being stagnant, there would be no resistance to the penetration of the acid digestive menstruum, consequently the stomach itself would be attacked if death occurred during the continuance of the digestive process. In the discussion which ensued, Dr. Miller observed that as the blood contained in the vessels of the stomach had secreted or discharged the acid digestive fluid, it must be in a much more alkaline condition than the general mass of the blood, a circumstance which would tend to support Dr. Pavy's theory.

Artificial Formation of Benzoic Acid from Aniline.—Dr. Hoffman described a remarkable series of experiments illustrating the artificial formation of benzoic acid from aniline. It is found that when aniline, $C_{12}H_7N$, is passed through a red hot tube it yields a certain proportion of benzo-nitrile, the formula of which is $C_{14}H_5N$; and further, that when this is boiled with potash benzoic acid is formed, which unites with the potash, forming benzoate of that alkali. The changes that take place in these reactions are remarkable as being the converse of those that usually occur in parallel decompositions, where the substances pass from a higher and more complex to a simpler form. Here, on the contrary, we pass from a lower to a higher state, and from a substance containing twelve equivalents of carbon to another which consists of fourteen.

Supposed Artificial Formation of Fibrine from Albumen.—A paper contributed by Mr. R. Hutchinson Smee was read by Mr. Savory on the supposed formation of fibrine from albumen. Fibrine containing a less per centage of carbon than albumen, Mr. Smee conceived that by directing a current of oxygen gas through the latter, a portion of the carbon might be removed by oxidation, and fibrine produced. The experiments showed that certain fibrous lines were produced by the passage of the gas, but there was no evidence adduced to prove that they were identical with fibrine in composition.

ROYAL GEOGRAPHICAL SOCIETY.—*Jan.* 12.

Reversed Ocean Currents.—Mr. J. A. Mann read a paper descriptive of a reversion of the Guiana current which took place in July and August 1862. In the discussion which ensued, Captain Maury, of the American navy, stated the immense importance of these observations, and that he was aware that the Gulf stream between Halifax and Bermuda had been known to run backwards to the south west, retaining at the same time its elevated temperature and other general characteristics.

Physical Condition of the Atlantic Sea Bed.—Dr. G. C. Wallich read a paper on the physical condition of the North Atlantic sea bed as affecting the success of Atlantic telegraphs. Hitherto soundings have only been taken at mean intervals of thirty-two miles, across an area of 1300 miles of sea. Dr. Wallich denied the proofs of a central Atlantic plateau, stating that the spaces between the previous measurements were sufficient to include some of the largest mountain ranges. Thus soundings of 100

fathoms had been taken within thirty-two miles of one of 1000 fathoms. Dr. Wallich suggested a fresh survey of the Atlantic by two vessels sailing in parallel courses two miles distant, and taking soundings alternately at five miles distance between any two soundings on the same line; this plan would give 640 observations respecting the deep sea bed in the Atlantic, as contrasted with forty-one obtained in the previous survey.

ZOOLOGICAL SOCIETY.—*Jan.* 13.

Mimetic Analogy in Birds.—In a paper descriptive of some new species of birds collected in Bourou, Mr. Wallace called attention to several new cases of mimetic analogy, or the imitation by one species of the plumage of another. In describing these specimens Mr. Wallace maintained, that the numerous cases of imitation that exist were incapable of being accounted for on any supposition except by that which accounts for the variation of species by natural selection; also that this imitation was a protection against the natural enemies of the imitating animal; that those animals most closely resembling the aggressive species were the most certain to escape destruction and perpetuate their variety; and that this method of natural selection acting through long periods produced the close imitation between species in totally distinct genera or orders, which appears capable of explanation on no other hypothesis.

BRISTOL NATURALISTS' SOCIETY.

This society, which was established in May last, is doing much to awaken an interest in scientific pursuits in Bristol. It numbers nearly 200 members, and from 60 to 100 attend its meetings, held the first Thursday in every month. Mr. W. Sanders is the President. In the summer, three excursion meetings were held, and various parts of the country around Bristol visited, chiefly, but not entirely, for geological purposes.

At the October meeting, Dr. W. B. Herapath made a communication, in which he gave a general view of the classification of Echinodermata, and made especial mention of the internal anatomy of *Uraster glacialis* and *Luidia fragilissima*. In a discussion which followed, Mr. W. L. Carpenter observed that he had seen specimens of Ophiocoma, partly digested, extracted from the stomach of a large Luidia. Also that his father, Dr. W. B. Carpenter, had employed *pure* glycerine, with the greatest success, for the preservation of many Asteridæ, and Ophiuridæ and Comatulæ also; the animal being in all cases slightly diminished in size by endosmose, but the colour perfectly preserved.

Mr. W. W. Stoddart, the hon. treasurer, then read a paper on some fossil plant beds of the Isle of Wight, which he had visited in the summer. After describing the beautiful scenery of the western part of the island, the author showed that the sections of the several

ages were very extensive and complete, while their ready access afforded great facility for palæontological study. The hazel-nut sands, Brooke Point, and chara seed beds of Colwell Bay and Headon Hill were first noticed, the latter being found in great abundance at Warden Point, and forming a magnificent object for the binocular microscope. The author remarked that the section at Brooke Point, from which he gathered the hazel-nuts and remains of Coleoptera, showed the bed to be placed *above* the gravel, and not *below*, as described in the Jermyn Street Memoirs. He then gave a short description of the pipeclay bed in Alum Bay, abounding in the leaves of as many as fifty-one species of Phanerogamic plants; pointed out the position of the beds with regard to the underlying Bagshot sands, and showed that, from a remarkable local disturbance, many of the beds had been thrown into a vertical position. The perfect absence of colour in the organic remains of this bed was then noticed, all those in the strata above and below being in the condition of lignite. The leaves were then described and shown to belong to sub-tropical plants, and the locality of the different genera pointed out—representatives of the Cassia, Banyan, and Tamarind trees occurring. The author concluded an interesting paper, illustrated by numerous specimens and diagrams, by drawing some deductions as to the probable climate of England during the deposition of these beds.

At the November meeting, Dr. Beddoe made some observations on the physical characteristics of the natives of the neighbouring districts. He compared them with respect to stature and bulk with the inhabitants of several other parts of Great Britain and Ireland, a number of measurements having been taken in conjunction with, or at the instigation of, Dr. Barnard Davis, one of the learned authors of *Crania Britannica*. The result of this comparison was, that the average stature of Bristolians was rather below that of the natives of the nearest rural districts, and considerably below the average of Scotland generally, and of Cornwall. The form and dimensions of the head differed little, but the author was of opinion that a judicious system of measurement would bring out more decided local or ethnological differences, and he instanced the more or less backward position of the greatest transverse diameter as a diagnostic between the Saxon and the so-called Celtic race. From evidence derived from 2500 observations, he showed that the colour of the hair was more frequently dark in Somerset and the west than in Gloucestershire or Wiltshire; Bristol men occupying an intermediate position, together with natives of the towns in Somerset. While protesting against the popular idea that the Celt, as compared with the Saxon, shows pretty uniformly great physical inferiority, Dr. Beddoe yet considered that many of the above facts could be best explained by ascribing them to ethnological causes. Wiltshire and Gloucestershire were conquered and colonized by the Saxons long before Somerset and Dorset, and subsequent immigration from the East would take place principally into the towns. The great frequency of narrow chins and prominent cheek-bones in the peasantry of Somerset might be accounted for by the predominance, up

to our own times, of Celtic blood. The author concluded by urging the desirability of bringing out and recording these local peculiarities before the increased facilities for migration and counter-migration afforded by railways, etc., obliterated them.

Mr. W. W. Stoddart then made some remarks on the employment of the Spanish Esparto grass, *Stipa tenacissima*, as a substitute for rags in the manufacture of paper, illustrating them with a complete series of specimens from Messrs. Somerville, of Bitton.

At the December meeting, Mr. Leipner, the hon. secretary, read a paper on textile vegetable fibres, with particular reference to *Zostera marina*, the proposed substitute for cotton. He commenced by observing that all textile fibres were derived either from the vascular or cellular tissue in plants, and that the first class of these was the most abundant. From the bark of perennial exogens were obtained bass (from a lime-tree), jute, Indian fibre, etc. In annual exogens, where the vascular tissue formed a small portion only of the stem, the whole stalk was used. To plants belonging to this class we owed all the hemps, flax, Chinese grass, Rhea fibre, etc. From endogens were derived New Zealand flax, Manilla hemp, Palmetta, and other similar fibres. The *only* example of textile fibres from the cellular tissue of plants was cotton, and for this reason the author did not expect that a *true* substitute for cotton would ever be found, all fibres hitherto proposed being obtained from vascular tissue, which conducted heat more rapidly than cellular tissue, and hence fabrics made from them were neither so soft nor so warm as those manufactured from cotton. In reference to the relative tenacity of various fibres, the author observed that, generally speaking, perennial plants furnished a far less tenacious fibre than annual plants, and also that the more tenacious fibres seemed to be produced by the most rapidly-growing plants. He then proceeded to speak more in detail of *Z. marina*, and concluded an interesting and well-illustrated paper by observing that the greatest obstacle to its use was the difficulty of collecting.

Mr. W. L. Carpenter then gave an exposition of Professor Graham's researches in Dialysis, specially explaining its varied applications, and illustrating his subject by experiments; but as an account of Dialysis has already appeared in our pages, we abstain from reporting this paper.

Mr. Leipner then communicated some notes on the natural history of a land-tortoise, from which it appeared that on July 25th, 1862, a female tortoise, which had been for upwards of fifty years in the possession of the family of Mrs. Williams, of Tregallon Scorrier, Cornwall, had laid some eggs, which were hatched in a pine pit at a temperature ranging from 70° to 85°. The male tortoise was obtained about four years ago, so that in the case of the female there had been a complete suspension of the generative functions for fifty years.

W. Lant Carpenter.

LITERARY NOTICES.

We have received many publications which we have not had an opportunity of noticing in a more extended form; among them are the following:—

Livingstone's Travels and Researches in South Africa, new edition, 8vo (Murray), placing this interesting work within reach of numerous readers, to whom the original and more expensive form was inaccessible.

Eccentric and Centric Force, a New Theory of Projection. By Henry F. Pratt, M.D. (Churchill).—The author of this work erroneously imagines that he can overthrow the foundations of astronomical science, and substitute a theory which he conceives more consistent with the glory of the Creator.

In quite another spirit the Rev. W. N. Molesworth, Incumbent of St. Clement's, Rochdale, contributes to popular education.

Plain Lectures on Astronomy (Ireland, Manchester; Simpkin, London). They are written in a singularly clear and interesting style, which proves their author to possess no ordinary power of presenting a difficult subject in an intelligible form. They have also the advantages of good print and low price.

A Lecture on the History of the Law of Gravitation, by Thomas William Burr, F.R.C.S. (Clement's, London), is also a good specimen of luminous explanation.

Observational Astronomy, Edited by Jas. T. Slugg, consists of cheap and handy diagrams, accompanied by explanatory letter-press, to assist amateurs in finding interesting objects amongst the various constellations.

Bird Murder (Wertheim), by a Country Clergyman, is an excellent tract against the cruel and mischievous destruction of the feathered inhabitants of our gardens and fields.

The Circle Secerned from the Square, by William Hamilton (Simpkin), is, as its name imparts, a mathematical paper.

Underground London, post 8vo, is the title of an agreeable work by Mr. Hollingshead, who cleverly sketches the numerous wonders of the subterranean regions of our metropolis.

The Year-Book of Facts and the Industry, Science, and Art of the Age, both by John Timbs, fcap. 8vo (Lockwood), manifest this veteran author's customary care as an indefatigable compiler. The last named is an excellent memorial of the Great Exhibition of last year, and has for a frontispiece an admirable photograph of the nave of the huge building and its multifarious contents.

Brambles and Bay Leaves, 8vo, is the second edition of Essays on Things Homely and Beautiful, by Shirley Hibberd, and is characterized by the intense love of nature and grace of expression for which its author is renowned. It is an elegant work for a present, or a prize in a first-class school.

Science Elucidative of Scripture and not Antagonistic to it, by John Radford Young, formerly Professor of Mathematics in

Belfast College, fcap. 8vo (Lockwood), is a controversial work battling with "Essays and Reviews," "Bishop Colenso," and the critical school.

To the above we may add sundry numbers of the QUARTERLY JOURNAL OF THE MICROSCOPIC SOCIETY, containing a variety of information and many admirable plates; and likewise of the EDINBURGH VETERINARY REVIEW, of special interest to those whose avocations connect them with live stock.

NOTES AND MEMORANDA.

FOWLS WITH BLACK PERIOSTEUM.—Mr. G. H. Inskip, Master in the Royal Navy, sends us the following: "Seeing, as if a thing of rare occurrence, in the "Notes and Memoranda" of the INTELLECTUAL OBSERVER for January of this year, some remarks on a Cochin China fowl with black periosteum, let me state that we frequently found, while employed surveying in the Gulf of Siam, the common fowls, purchased at Bangkok and along the coast, to have apparently black bones, with dark flesh, looking as if saturated with pale black ink. We preferred eating the fowls not so discoloured, more on account of their appearance than from any marked difference in their flavour."

PILLISCHER'S NEW MICROSCOPE AND LAMP.—We have carefully examined the instrument which Mr. Pillischer designates the "New £5 Prize Microscope," and find its merits of a very high order. Those who can spare the money will, of course, prefer a higher-priced and more perfect construction, but this pattern supplies all that is really necessary for the instruction of the student or the gratification of a family sufficiently intelligent to devote its evenings to rational pursuits. The new Microscope is distinguished from other educational instruments by possessing a very simple and ingenious mechanical stage, and by having a dividing object-glass, constructed upon optical principles very superior to those of the ordinary French and German combinations. The stage movement is founded upon the action of the elbow joint and shoulder of the human arm. On the left-hand upper corner of the stage is a pivot, on which a brass arm moves. This arm is continued down the left-hand side of the stage, and is connected with the object-holder by an elbow joint. By applying the thumb and finger to a projecting pin with which the object-holder is furnished, and steadying the hand against the stage, a variety of movements may be obtained in horizontal and vertical directions, and every part of a large object successively brought into the centre of the field. The peculiarity of the object-glass consists in such an arrangement of lenses and stops, that the quarter-inch may be reduced to half-an-inch, and that again to an inch, without any practical deterioration of performance. The quarter-inch shows the *Pleurosigma hippocampus* beautifully, and works well on a Podura scale. The half-inch has a flat field and excellent definition. Several which we examined stood tests that we scarcely thought it fair to apply, and the one-inch is a thoroughly good working power. No dividing combinations can possibly equal separate objectives, worth four times their price; but Mr. Pillischer has so successfully minimized the evils of this system, as to meet the requirements of the majority of microscopic students.

Mr. Pillischer's lamps are of very elegant construction. From the position of the reservoir they throw no shadow. When used for the microscope, they have a shade which admirably imitates the favourite "white cloud illumination," and when employed as reading lamps this may give place to a shade of similar shape, which throws a white light on the book, and offers a pleasant, cool, green surface to the eye. The chimney is either of common glass, or with a bluish tint. The latter so completely corrects the slight yellowness of the flame as to permit blue and green to be readily distinguished, and colour-top experiments to be performed almost as well as in broad day.

Illuminating Shells.—M. France, a lieutenant of artillery, says *Cosmos*, has invented a shell which illuminates an area of several hundred yards. Three or four of them are found sufficient to light up an extensive plain.

The Aurora of December.—The splendid Aurora of the 15th of last month was well seen at Marseilles and in Northern Italy. At Puycharnaud (Dordogne) soon after sunset, a writer in *Cosmos* describes the sky as of a brilliant gold tint. At 5·20 p.m. this disappeared, and was followed by a luminous rose-coloured cloud, which enveloped the three conspicuous stars of the Great Bear's tail. A quarter of an hour later a similar cloud formed towards the east, and then both disappeared. They were immediately replaced by three spots of silvery or greenish white, one in the magnetic meridian, and one on each side of it about 15° above the horizon. In a few minutes afterwards numerous streaks of light radiated from these centres, gleaming with white, purple, and rose. The changes were rapid, and usually ended in pale or shaded green. This stage of the aurora lasted about twenty-five minutes, and was followed by a period of repose, but the whole northern sky was illuminated. At nine the corruscations began again with still greater splendour of tint and variety of form. At nine and three-quarters came another calm, and the arc which had been the scene of the brilliant effects assumed the aspect of a lake of molten silver. This appearance diminished, and seemed over by eleven. At 11·20 a fresh column of light appeared, and new splendours were exhibited. A little before midnight a few flashes were seen over the horizon, but the moonlight caused them to disappear. When the aurora was at its height at 6·50 p.m. a globe of white light twice the apparent size of Venus made its appearance near the pole, and moved slowly towards the horizon from south-east to north-west. A similar globe was seen about half-past eleven. The display lasted for six hours and a-half, during which the compass-needle was in continuous agitation.

Philosophy of Winds.—Mr. Thomas Hopkins, M.B.M.S., recently read a paper before the Manchester Literary and Philosophical Society to show "that air going from certain slowly revolving polar localities to others that revolve more swiftly, is not left behind in the way that is generally supposed." He states that on the east side of the Atlantic, in the Gulf of Guinea, air passes towards the east, not only without being left behind, but with additional speed," and that "in like manner winds blow on the eastern side of the Pacific within both northern and southern tropics, and must, therefore, rotate eastward more swiftly than the surface on which the air presses. It was contended that the cause which determined the air constituting these winds to rotate faster than the surface of the globe that was beneath them, ought to be considered that which makes other winds pass over the surface when they do not move with equal rotatory velocity, and were, therefore, said to be left behind." He considers that the atmosphere presses on the surface of the globe with a force that causes the air to move with the surface in its rotation, unless its own uniformity of pressure is disturbed.

A Luminous Night.—Mr. Baxendell, F.R.A.S., communicated to the same society the singular fact that on the night of the 24th October, 1862, although there was no moon, nor visible aurora, there was for two hours enough light in the air to allow buildings and hedgerows to be distinctly seen in the country round Mr. Worthington's observatory.

Microscopic Use of Magenta Dye.—Dr. Roberts pointed out to the microscopic section of the same body the advantage of employing the Magenta dye to tinge blood globules or animal cells. It causes nuclear structures to be distinctly displayed.

White Substances.—In "Some Remarks on Light" read before the Microscopical Society of Newcastle-upon-Tyne, Mr. B. S. Proctor observes, "Precipitated chalk far outshines the natural varieties, and fine qualities of carbonate of magnesia outshine it. Of a great number of substances I have compared, Howard's carbonate of magnesia is the whitest, and microscopical examination indicates that it consists of clear, colourless particles, but very minute."

Microscopic Exhibition of Starch.—In the same paper Mr. Proctor observes, "I have here three mountings of tous-les-mois ..... you will observe that which is in balsam has a dark centre while it is beyond focus, is uniformly light at

focus, and has a bright centre when within focus, indicating that the balsam has a higher refracting power than the granules; with that mounted in the gelatinous medium, you will find the effects of increasing and diminishing the distance from the object-glass are reversed, indicating that the starch has now a refracting power above that of the medium in which it is enveloped, and the markings on its surface are in this mounting much more distinct."

Iodine and Sulphur.—M. Diethenbacher states that if one four-hundredth part of iodine is added to sulphur heated to about 180° C (356° F.), and the mixture poured on a slab of porcelain, there results a sheet of the material which is easily detached, and which retains for several hours, and even for several days, a remarkable elasticity. It possesses a metallic lustre, and takes impressions with great fidelity.—*Comptes Rendus.*

Peculiarities of Thallium.—The commission on Thallium appointed by the French Academy, remark that its discovery forms an epoch in the history of chemistry, on account of the astonishing contrast between its chemical and physical characters—they call it the "ornithorynchus of metals." It has nearly the same appearance as lead, may be cut in a similar manner, and leaves a similar trace on paper. It has, moreover, the same density, nearly the same fusing point, and the same specific heat. Its solutions, like those of lead, yield a black precipitate with sulphuretted hydrogen, a yellow one with iodides and chromates, and a white one with chlorides. But it indubitably belongs to the family of alkaline metals, which recent discoveries have doubled in number. In this list Thallium stands, as regards the weight of its equivalent, at the opposite extremity of the scale to Lithium, the numbers being, Lithium, 7; Sodium, 23; Potassium, 39; Rubidium, 85; Cœsium, 120; Thallium, 204. The Commission remark that the equivalent of Sodium is exactly the mean between that of Potassium and Lithium; that if double the atomic weight of Sodium is added to that of Potassium, the equivalent of Rubidium is obtained; that adding double the weight of Sodium to double that of Potassium, gives very nearly that of Cœsium; and that adding double the weight of Sodium to four times the weight of Potassium, gives nearly that of Thallium. The equivalents of all the alkaline metals, Thallium included, must be halved to make them fit Dulong and Petit's law concerning the relation of atomic weight to specific heat. The Commissioners further observe that the alkaline metal series contains one, Lithium, whose atomic weight is so light as to place it near hydrogen, and another, Thallium, so heavy as to rank with Bismuth, whose equivalent is the heaviest known.—*Comptes Rendus*, 15*th December*, 1862.

Corymorpha nutans.—Professor Allman, in "Notes on the Hydroida," communicated to the *Annals of Natural History*, states that, as Edward Forbes suspected, the medusoid of the Corymorpha nutans belongs to the form described by that naturalist as Steenstrupia. Besides the production of medusoid sexual buds, he observed another mode of reproduction, the exact significance of which he was unable to ascertain. It consisted in the formation of minute oblong bodies, which developed a small polyp at one extremity. He considered them to arise from gemmation, and thrown off by adult specimens in some way unknown.

Magnetism, Electricity, and Vegetation.—In his *Physique du Globe* M. Quetelet tells us that on examining attentively the value of the monthly magnetic variation, it is found to be in direct relation with the force of vegetation. When the latter sleeps, which happens in the months of November, December, January, and February, the magnetic variation, at Brussels, is almost uniformly 5′ 28″, or scarcely half during the period of its full activity, that is to say, from April to September, when its mean is 10′ 15″. It reaches its plenitude in April, when the mean is 11′ 14″, for Brussels. In another passage, M. Quetelet states, that the electricity of the air is intimately connected with the action of vegetation, and that the two phenomena have a nearly parallel march. It is not pretended that one depends on the other, but that both arise from the same cause. The quantity of atmospheric electricity at noon is much greater in winter than in summer, the relation being about 10 to 1. This augmentation of electric force proceeds in a manner almost parallel with the number of days of frost and fog, and inversely as the number of days of thunder, of elevation of temperature, of actinic power.

F. W. Fairholt, F.S.A.

1. Glass Lamp with painted surface. (Early Arabic.)
2. Ewer, in 'Henri Deux' Ware
3. Gilt Cup, given by Henry VIII. to Barber-Surgeons' Company.
4. Silver Cup, partially gilt, given by Charles II. to ditto.
5. Cup in black and white Limoges enamel, gilt. (Baron Rothschild.)

THE INTELLECTUAL OBSERVER.

MARCH, 1863.

THE LOAN MUSEUM OF ART OF 1862, AT SOUTH KENSINGTON.

(*With a Coloured Plate.*)

BY THOMAS WRIGHT, F.S.A.

It is only within our own time that archæology in this country —and especially the archæology of the middle ages—has really become a science. This is very easily explained. Formerly, any object of antiquity was looked upon merely as a thing in itself. The individual who became possessed of it, if he was a mere collector, put it among his curiosities, or, if he was a man of some information and ingenuity, seemed to think that the mere possession of it gave him the faculty of judgment upon everything connected with it, and he indulged the public with wild speculations, which only brought antiquarianism into contempt, and science was injured by the very discoveries which ought to have benefited it. It was only slowly that people began to understand that one object is of small value unless you have others to compare it with, and even now the notion is not quite obsolete that every man who becomes possessed of an object of antiquity is thereby qualified to write a dissertation upon it. But, the necessity of extensive comparison once understood, it became every day better and more largely appreciated, and, of course, knowledge increased in proportion. Yet this revolution in archæological feeling produced a reaction which also had its evils. Remarkable monuments of mediæval and post-mediæval art had remained concealed in the cupboards of private families, or in small collections which were equally unknown, and these, dragged into publicity by the large pecuniary value which they suddenly obtained, excited a sort of enthusiasm which gave them an undue antiquarian and artistic importance.

The influence of this mistake is still felt very greatly, and the only means of correcting it is an increase of knowledge, by the opportunity of still more extensive comparison. It is the

feeling of this want which has led, during some years past, to the desire of establishing collective exhibitions. The works of art of the middle ages and the renaissance, the pecuniary values of which are very extravagant, are rarely collected in large museums, but are scattered among a number of wealthy individuals, and are thus inaccessible to the general student. The sort of public feeling excited by the announcement of an exhibition of this kind draws from their hiding-places important examples of art, which in some cases would have remained absolutely unknown, with the additional advantage of being placed side by side with similar objects from other collections, and thus, though the opportunity of minute study is not great, people have a chance of obtaining enlarged views on the subject which would not otherwise be accessible. During the last ten years several experiments of this kind have been made, but none on so extensive a scale and so generally satisfactory as the Loan Museum at South Kensington during the past year.

The objects brought together on that occasion were so numerous and so varied, that, although they were classified, it would be useless to attempt anything like a general description of them, except by a catalogue, and a very good catalogue of the collection has been published under the direction of the Science and Art Department of the Committee of Council on Education. But we may try to show briefly the real character of this remarkable assemblage of works of art, the advantages which may be derived from it, and more especially the manner in which it illustrates the history of ornamental art since the period which, in classical language, is called antiquity. This latter view of the subject is the most interesting of all, because it is most intimately connected with the history of human intelligence and social progress.

The love of ostentation is a passion inseparable from humanity, which shows itself in various forms under the different circumstances of society. According to the accounts of the ancient writers, the primitive inhabitants of our island, that is, the uncultivated Britons of the wilder districts, having nothing else to ornament, painted their skins, and thus made the most of their nakedness. For the style of art which thus existed among them we have no other voucher than the imaginations of some ingenious artists, who have attempted to represent pictorially what the ancient writers have only hinted at. We can place no examples of painted Britons in a modern loan museum, and of course Roman art is beside our present purpose; but we are enabled from a very early period to trace the artistic tastes of some of the peoples who united in forming the middle ages, so as to judge even of the individual influence which each exerted in the subsequent amalgamation. In those rude ages,

and indeed until a comparatively late period, the love of ornament at a particular period was generally confined to not more than one or two classes of objects, and in general the particular class thus distinguished was especially characteristic of the social condition of the age. No one will deny that, if the ancient Britons employed their artistic skill in painting and tattooing their naked bodies, it is a tolerably satisfactory proof that they had little else to display. When, however, we become acquainted with our Teutonic forefathers, we find them in a totally different social position, and we see several directions in which the taste for ornament might be displayed. First, as great warriors, we might suppose them ostentatious of their arms; secondly, they might adorn their persons; and, in the third place, they might make a display of ornamental riches in their dwellings. The remains of Teutonic poetry speak in rather exaggerated terms of the beauty of their arms, but their ornamentation of these appears to have been chiefly lavished on the hilts of swords, and these were distinguished most by the value of the material. Almost the only ornament of the dress which remains is the fibula, which fastened the mantle on the breast, and this, though often large and elaborately worked, shows chiefly a great desire to exhibit the precious metals, for, if not, as in a few instances, of gold or silver, it is of copper, rather thickly gilt, so as to make show of gold. We can easily understand this desire to display the precious metals, when we consider that they formed the most valued part of the plunder of the Roman provinces, and that the possession of them was considered as evidence of bravery in war as well as of wealth. Hence the display in the interior of the Teutonic household was considered the most important of all. Not that the houses were elegantly furnished, for the only important room in the house—in fact, nearly the whole house itself—was the hall, and that consisted of little more than bare walls, but the chieftain stored up in his coffers vessels of Roman goldsmiths' work, formed of gold and silver, which he had gained in his inroads into the Roman provinces, and which he brought out only to display at the festive board. For many reasons, therefore, these were the ornamental objects on which he placed the greatest value, and this explains why, in the earlier periods of the middle ages, the goldsmith's art was one of those held in highest consideration. Vessels of gold and silver, and jewellery, were the works on which chiefly art was employed, and the craft of the smith, as applied to such objects, was considered so honourable that it was exercised by some of the greatest men of the age, such as, in England, Archbishop Dunstan and Bishop Ethelwold. As the church became powerful and wealthy, the ecclesiastics appeared as the great patrons of the goldsmith's art, and the most

splendid examples were crowded into the treasuries of the cathedrals and monasteries.

The desire to give increasing beauty to these works brought into repute enamel and niello, and other similar contrivances, all of which had been practised by the Anglo-Saxons. But the art of enamelling took a great development towards the twelfth century, when the celebrated manufactory was established at Limoges, it is supposed by Greek artists from the East, and where it continued to flourish till the fourteenth century. During the twelfth and thirteenth centuries this manufactory was extremely active, and an immense quantity of very beautiful enamels was supplied, many examples of which are still preserved. With the Limoges enamel came a great improvement in the style of art. The half-barbarous chieftains of the earlier period valued, in the objects of art they displayed, first, the metal, because it was a measure of their wealth, and therefore of their power; and, secondly, the workmanship, because the more elaborate this was, the more it must have cost to produce it. The skill of the worker in metal was so much esteemed that it was believed to have been first exercised by semi-gods, such as Weland, and by the elves in the mountains, and by them granted to favoured individuals among men. But this skill consisted in ingenuity and labour, for the early artists had little notion of design, and none of correctness or elegance of form. If the objects were made of gold, covered with plenty of filagree-work and such ornament, and glittered with precious stones, or glass, or enamel, it was enough; and when, from the scarcity of the precious metals, or from the greater call for such objects of ornament, it was necessary to make them of cheaper materials with a mere superficial resemblance, all that was required was that the ornamentation should be elaborate and showy. But with the Limoges enamels we trace a decided improvement in art, just such as we might expect to be brought from a country where the tradition of the arts of antiquity was more vivid.

While the art of enamelling was establishing itself at Limoges, another branch of art was becoming more largely developed; this was carving in ivory. It was an art which had grown up in the later Roman period, and seems to have been brought into western Europe from Italy during the Carlovingian period. It was established at about the same time in Germany and France, which countries continued during the middle ages to be those where this art was chiefly cultivated. An ivory carving can only please by its beauty of execution, and it was necessary for the artist to study correctness of form and design. Hence the carvers in ivory were generally the superior artists of the time, and their subjects were pictures. Ivory appears to have

been first used for tablets, on which pictures were carved, chiefly of religious subjects, some serving as portable altar-pieces, and others as provocatives to pious reflection. It was then employed in the construction of small chests or coffers, which also were adorned generally with pious subjects. Many of them were no doubt made for ecclesiastics, or for ecclesiastical purposes; but it is probable also that many of the tablets as well as the coffers were made for ladies, for whom such subjects were considered most suitable. As social life became developed, this destination of the ivory-work becomes more and more evident, and the religious subjects begin to be abandoned, and in their place we find subjects taken from the mediæval romances, especially such as were likely to be favourites with the ladies, from love allegories, etc.; and these are given not only on coffers, but on the frames and cases of ladies' mirrors, combs, and other similar objects. The ivory carvings of the thirteenth and fourteenth centuries, which appear to have been executed most extensively in France, often display a very superior style of art.

During the whole mediæval period, the application of art to pottery seems to have been entirely lost, for mediæval pottery is distinguished only by its rudeness; but the glass-manufactories of the late Roman period appear to have been continued; and, as we learn from the remains found in their graves, the Anglo-Saxons and other Germanic tribes, from a very early period, prided themselves on the possession of vessels of this material, which was especially employed in making drinking cups, which display more artistic taste than most of the objects of art belonging to the same period. We can only here speak of the period before the conversion of the Anglo-Saxons to Christianity, when, in accordance with their pagan ceremonies, they deposited glass vessels in their graves, which has been the means of preserving them; but the material is so extremely fragile that we need not be surprised if, during several centuries, we have so little remains of vessels in glass that we might almost suppose that they never existed. Improvements in glass-making appear to have been introduced from the East, where it was brought to a certain degree of perfection during the thirteenth and fourteenth centuries. A few remarkable specimens of oriental glass, which had found their way into western Europe during the middle ages, have been preserved, and some of them were placed in the Loan Exhibition. They are remarkable for the amount of ornamentation bestowed upon them, and for the different processes employed in ornamenting the material. Some of them are vessels for domestic purposes, but among the more curious are the large ornamental lamps used for lighting the mosques. The best of the three lamps exhibited at South Kensington is

represented in our plate (Fig. 1). It is nearly fourteen inches in height, and eleven and a-half in diameter, and has six loops for suspension. The medallions on the upper part enclose a device composed of a red chalice-like cup, with a red hemisphere above and a black hemisphere below. Between the medallions and on the body of the lamp below are two inscriptions, the first of which is a verse from the Koran, the translation of which is, "God is the light of the heavens and the earth; the similitude of His light is as a niche in which is a lamp." The inscription below states that the lamp was made by order of the Emeer Sheykhoo, who was a contemporary of the Sultan Hasan, who reigned from 1348 to 1362. This lamp is now the property of Felix Slade, Esq. The celebrated Venetian glass began to be manufactured in the fifteenth century, and the manufacture continued to flourish until the first half of the century following.

At this later date began the great movement for ornamental pottery, for till that period pottery was not admitted as a work of art, but was of rude make and used chiefly for common purposes. The lead in this movement seems to have been taken by an individual whose name is not known, but who flourished in France in the latter part of the reign of François I. and through that of Henri II., and who was possessed of very great artistic taste and skill. It is supposed, from some characteristics of the ware itself, that he was originally a goldsmith or jeweller. Whoever he was, he raised the art of pottery at once almost to its highest pitch of excellence, and, besides the elaborate character of the processes employed in producing it, it was long before pottery again presented the same degree of artistic beauty. It is evident that this "Henri II. ware," as it is called, was at the time looked upon as a great effort of art, and that it was very expensive, for the small number of examples which remain bear upon them the indications that they were all made for the king or for some of the great princes of France. We have given in our plate (fig. 2), as an example of this ware, a representation of an ewer or arguière, which is considered to be the finest of the existing specimens. It is in the collection of Hollingworth Magniac, Esq., and was exhibited in the Loan Museum (No. 1200). It is also the largest specimen, for its extreme height to the top of the handle is fourteen inches and a half, and its greatest diameter is five inches and three quarters. Its elaborate ornamentation will be best described in the words of the authorized catalogue, given in the note below.* This production of artistic pottery

* "The body of the piece is oviform; all the plane surfaces are covered with incrusted interlaced ornament of several different designs; the pattern on the lower part of the body containing the letter 'G,' repeated in the centre of numerous small compartments, formed by the interlaced diaper; on the widest or most salient part of the body four beautifully modelled Medusa masks, in high relief, are attached or applied. The foot or base forms a series of elaborate mouldings,

was followed immediately by the pottery of the celebrated Bernard Palissy, who was, in fact, a contemporary of the anonymous potter-artist of the reign of Henri II. Like the Henri II. ware, the Palissy ware was an imitation of the embossed goldsmiths' work; but it was more grotesque, and displayed far less taste. It was much more curious than beautiful. This manufacture flourished in great activity during the latter half of the sixteenth century, and appears to have been kept up by some of the family, or by imitators, until it fell into neglect on the extensive importation of oriental porcelain, and we have no more European artistic pottery of any great merit until the establishment of the manufacture of porcelain at Sèvres, and the various descriptions of porcelain afterwards manufactured in Germany and in England.

These attempts to introduce high art into the manufacture of pottery had been preceded by a revival of the enamel works at Limoges, although the new enamel differed very considerably from the enamel of the twelfth and thirteenth centuries. The new productions are termed painted enamel, because the surface of the copper was covered with a uniform coating of enamel, usually brown, on which the subjects were painted. This new style of enamel began in the latter part of the fifteenth century, attained its greatest excellence in the latter part of the sixteenth, and fell into decline early in the century following. The example given in our plate (fig. 5), which was exhibited in the Loan Museum by Baron Rothschild, belongs to the best period, about the year 1580. Its form is not inelegant, and the ornamentation is very superior. The ground is a brilliant black, decorated in blue, green, and gold, with heads in circles, painted *en grisaille*, to imitate cameos. The taste for a display of ornamental plate had undergone no diminution during the middle ages, and its manufacture went side by side with the new works in porcelain and enamel. It was at the court of Burgundy that this passion reached its greatest height of extravagance, and the princes and nobles carried their treasures about with them, in

further enriched by applied strap-work scrolls in relief, pecten shells, cherubs' heads, etc. The neck of the ewer, likewise richly diapered with encrusted ornamentation, is divided into two portions by a bead or torus moulding in the centre, the portions above and below this moulding respectively being campaniform, each of the bells being turned in opposite directions. The spout or mouth of the vase is shaped as a large pecten shell, underneath which, in front, another grotesque female mask is attached to the neck of the vase; the handle is formed by a syren with her head downwards and fore-quarters resting on the body of the vase, whilst the extremities are formed by two serpents, which form the elegantly curved grip of the handle; the involuted extremities, where they join on to the large pecten shell at the mouth of the piece, terminate in two serpents' heads modelled with great spirit." It may give some notion of the great value set upon these objects of art of the middle ages and the renaissance, to state that this piece of pottery is said to be worth at least two thousand pounds.

order that they might display them wherever they halted. Every reader of history remembers the vast treasures in plate and jewellery which Charles the Bold carried with him when he invaded Switzerland in 1476, and how, after his defeat in the battle of Morat, these treasures became the plunder of the Swiss, fell into the hands of dealers, and were soon scattered over Europe. In the progress of ages, plate has been more liable to destruction than most other objects of art, in consequence of the continual tendency to melt it down, in order to employ the metal in more useful purposes, or to make new and more fashionable objects; and hence almost the only examples of early plate which remain, especially of English manufacture, have been preserved by corporate bodies, and have, perhaps, some peculiarity of character, arising from the corporations for which they were made. However, there can hardly be said to be any general character in ancient plate, each example, in a manner, standing by itself; and, instead of attempting to select examples which might serve as types, we have been satisfied to give two which are interesting for their historical associations. The first of these (fig. 3) is a cup, which was given by Henry VIII. to the Company of Barber-Surgeons in London, at the time of granting their charter, an act which is commemorated in a large painting by Holbein, still preserved in the hall of the company. The cup is of silver-gilt, the cover surmounted by the royal arms, with Tudor supporters. The other cup (fig. 4) belongs to the same company, having been presented to them by Charles II., and is intended to commemorate the shelter afforded to that monarch after the battle of Worcester by the oak of Boscobel. It is also of silver, partially gilt; the stem and body represent an oak tree, from which hang little bells in the form of acorns. The cover is surmounted by the royal crown.

In the Loan Exhibition of last year, all these branches of ornamental art, and some to which I have not alluded, were tolerably well represented. The Anglo-Saxon case was most imperfect, which was a matter of some surprise, considering the great number of antiquities of this period which have come to light during the last twenty years. On the other hand, the Loan Museum was very rich in carvings in ivory, which formed perhaps the most interesting division of the whole collection, and in Limoges enamels of all periods. The collection of old glass was good, and all the branches of art of the later periods of the renaissance, and of the age which followed, were abundantly represented. Thus, in an historical point of view, in which consists the great importance of such a collection, the Loan Museum was tolerably complete; yet every one must have felt that its utility would have been greatly increased by a

little more historical arrangement, and if the visitor, in passing from one table or case to another, had been allowed to take the different classes of objects in something like their historical order, instead of jumping from new to old, and from old to new, until he lost all perception of the relations of the different classes to each other, he would, no doubt, have been benefited by it. Each class, too, might have been so arranged as to show the gradual development of the art which it represented. Thus, though we could not have started with art as it was cultivated by the uncivilized Britons, we might have traced it in its more barbaric form among the ancient Irish and the Anglo-Saxons, in the first development given to it by the earlier mediæval ecclesiastics, in the advance it made under the influence of Greece and Italy in the enamels, ivories, and illuminations of the twelfth and thirteenth centuries, till at length we come to the universal splendour of the renaissance.

It is curious to observe as we go on how slowly, and with what apparent difficulty, the purity of ancient art made itself felt in the mind of the mediæval artist. The love of elaborate ingenuity and showy display which had characterized mediæval art at the earliest period predominated throughout, and was never more strongly apparent than in the works of the renaissance, however excellent the execution of the details may have been. Art, like costume, had become an affair of fashion, and not of pure taste, so that it varied in forms and character from year to year, and in this chiefly consists the historical interest of such a museum of objects of the later periods. And amid all this extensive display, we cannot help being struck with the great absence of real beauty—it is all comparative, and in the whole collection we could select but few objects to recommend for imitation at the present day.

A SABELLA BUILDING ITS TUBE.

BY PHILIP HENRY GOSSE, F.R.S.

The following particulars of a process of animal mechanics may possess interest for readers who study marine zoology under aquarian auspices, and I am not aware that they have been recorded before in detail. I give the *ipsissima verba* of my journal, written while the little mechanic was before my eyes. The account is an incidental testimony to the adequacy for aquarian purposes of the substitute for sea-water, the constituents of which I first made public in the *Annals of Nat. Hist.* for 1854:—

June 30. My large tank of artificial sea-water, made in

August last, is now very rich in animal life. The stones and old shells are clothed with a woolly down of (probably) *Ectocarpus,* and the whole has the settled, old appearance of a natural pool bottom. Among the inhabitants is a *Sabella,* which answers in all particulars to Montagu's *S. vesiculosa,* except that it is much shorter than his specimen, being about one and a-half inches long, and its tube, at least the free part, about two inches. The dark purple vesicles which he mentions at the tip of the gill filaments, are in mine much more conspicuous than represented in his figure, that of the anterior filament on each side being much larger than the rest, and forming a stout, globose, nearly black ball; the others diminish to about the twelfth on each side, where they disappear. These balls are placed on the inner or upper face of the filament stem, at the point where the pectination ceases, the stem itself being continued to a slender point beyond it—the "short hyaline appendage" of Montagu. From their great resemblance to the tentacled eyes of the Gasteropod mollusca, I have little doubt that these are organs of vision. If so, the profusion with which the Sabella is furnished in this respect may account for its excessive vigilance, which is so great that not only will the intervention of any substance between it and the light cause it to retire, but very frequently it will dart back into its tube almost as soon as I enter the room, even while I am ten feet distant.

This morning I found my Sabella clean out of his tube, and lying on the muddy bottom below. I was afraid he was moribund; but he was actively wriggling, and his beautiful disk blossomed as widely as usual, though grovelling on the sand. Some six hours elapsed, when I perceived that his body was no longer naked, but enveloped in a new, loosely-constructed, but rather tightly-fitting tube, from the posterior part of which the naked tail was protruding, as yet unprotected. It was evident that the Sabella was meeting the emergency of his situation by forming a new dwelling, and that he had commenced, though unseen by me, by making a ring of mud cemented with a gummy secretion around the neck, which ring, as it increased in length, was continually pushed farther and farther downwards towards the tail.

The process of natural manufacture is always interesting. I removed my artificer from the tank, and put him alone into an ample cell of glass with parallel sides, giving him plenty of water, and a bottom of sand, on which I allowed to fall through the water a little clay, rubbed to a paste between my fingers in the water. As soon as the turbidity had a little subsided, so that I could use a lens, I had the gratification of seeing how he proceeded.

In order to make this intelligible, I must briefly describe the structure of the parts engaged. All that is ordinarily seen of the animal is a flower-like disk protruding from the tube. This disk is composed of two semicircular fans (the gills), the pair forming a complete circle, except that the points of junction, behind and in front, are marked by a slight opening. Each fan consists of twenty-one feathers, regularly radiating, and curling outwards with a beautiful turning-over of the tip, so that the whole disk bears the closest resemblance to a trumpet-shaped flower. The filaments, which I have called *feathers,* consist each of a slender stem, beset on the sides with two rows of beards (*pinnæ*), whose direction is upwards and outwards from the stem, so as to make a groove, of which the face of the stem is the bottom. The beards are in constant active motion, some being thrown inwards every instant, striking, and as it were feeling, the water, every one quite independently, moved by an impulse of its own. Under a high power (500 diam.) all the beards and the exterior face of the stem also, are seen to be clothed with minute, but rapidly vibrating, cilia.

In the centre of the flower-like disk is the mouth, which is guarded by a pair of little pointed tentacles, and on the outside of the disk, at the base, there runs round a thin, fleshy, very flexible collar of membrane, which, at the posterior opening of the fans, or that which is opposite to the two principal eyes, is produced into a pair of moveable, soft, tactile flaps, which turn outward, and hang over the edge of the tube in course of house building.

All this being premised, and the workman's tools being thus described, let us see how he works with them. Suppose him to be lying along on the bottom, near one corner of the square glass vessel, so that through one side a lens can be brought to bear on one side of the animal, and through the other on the disk.

We first glance at the disk, taking a front view of the creature. The filaments of the gill-fans are so active, bending inward and outward, and perpetually crossing one another, and the pinnæ are jerking hither and thither so incessantly, that we are for a while confused, and can make out nothing. We must fix our eye on some individual filament, and watch that, heedless of all the rest. Now we perceive that the tip of this is bent over outwardly, until the inner face of it is in contact with the bottom, the pinnæ expanding over the clay like the legs of the letter A. In an instant these close together, seizing, as with so many opposed fingers, a little of the soft and impalpable clay, and at the same instant the filament is straightened from its recurved condition, and we perceive a

minute pellet of clay lying between the pinnæ. The pellet takes a lengthened form, and presently glides quickly and equally along the groove of the pinnated filament towards the mouth, carried along by means of the cilia with which every part is clothed. Glancing at other filaments on each side, we see a similar pellet in each—at least, of those which, as the disk lies, are in contact with the bottom. As we follow the tiny mud pellets to their destination, we trace them to the mouth, where the two pointed tentacles stand guarding the entrance; these appear to guide the united pellets to the posterior orifice between the fans, through which we see the lump making its exit.

"We can learn nothing more of its progress from this point of view; but let us now direct our lens to the side of the animal. Here we again see the soft lump emerging between the fans, and as it progresses, the moveable fleshy flaps above described receive it, and guide it to the edge of the tube, plastering it as if with trowels on the edge, regulating its thickness, and smoothing it down. Meanwhile, the animal slowly revolves on its long axis, by which means all of the filaments in turn are brought within reach of the ground, and thus the labour of feeding the trowels is fairly distributed, and, also, the deposit is made in succession upon every part of the edge of the tube.

The tube increases in length by means of this process with considerable rapidity, and it is not long before the animal is once more completely protected. Probably, as the desertion of the old tube was in this case voluntary, it is not unreasonable to infer that the formation of a new habitation is normal, and takes place at certain, probably irregular, intervals, through life. There seems to be an inner layer of gummy matter secreted from the collar, on which the mud pellets are moulded; and often the lower portion of the tube—the first formed—is found in this genus of worms firmly adherent to a stone, and consisting almost wholly of this gummy matter without any mud coating. The substance, which hardens in water, and is insoluble, is of a horny texture and colour, a pellucid yellowish brown, and is probably composed of chitine. Perhaps in the case before me, if the animal had been reposing on a stone, instead of soft mud and sand, the first-formed portion of the tube would have been adherent.

I add Montagu's description (slightly condensed) of the species, the accuracy of which is proved by my specimen:—"*Sabella vesiculosa.* Body with many segments, pale, dull orange, minutely speckled with white. . . . . Tentacles [gill fans] two, with about twenty-eight long ciliated fibres each, olive green, mottled with gray, partly in bands when

expanded; not forming a circle, but sub-convolute, the under part turning inward. At the points of each ray is a dark purplish vesicle, most conspicuous on the anterior ray of each plume, terminated by a short hyaline appendage. Mouth gaping; lips whitish, with two slender cirri; behind the tentacles a scolloped membrane surrounding the anterior end of the animal. Length six or seven inches. Tube coriaceous, but always coated with coarse sand and shells, ten or twelve inches in length."

DE CANDOLLE ON DARWIN'S THEORY.

The *Archives des Sciences* has published some elaborate papers on the "Study of Species, on the occasion of a Revision of the Cupuliferæ,"* by M. Alphonse de Candolle; and in one, which appears in No. 60 of that journal, we find the following important remarks:—

"I shall take this occasion to speak of the system of Mr. Charles Darwin, the most modern, and at the same time the most ingenious and complete, of the systems founded upon the evolutions of organized beings in the course of time.

"The progress of geology having demonstrated the antiquity of organized beings in terrestrial strata, and a succession of forms, according to sufficiently regular laws, it necessarily happened that the idea of a successive derivation of forms from other forms older than themselves should acquire new favour. The triumph of the system of the epigenesis† of organs conducted to it by analogy, and the recent experiments which have once more rolled back the theory of spontaneous generation, augmented the inevitable tendency of naturalists towards the doctrine of evolution. In fact, if we had been certain that inorganic bodies were transformed to-day and under our eyes into organized beings, it would appear quite plainly that at certain epochs, and even frequently, the same thing must have happened. But precisely the contrary is demonstrated, and it is therefore probable that formerly, as now, forms have been changed by evolution from forms which previously existed.

* "Cupuliferæ (*cupula*, a little cup, and *fero*, to bear) the nut tribe. A natural order of Dicotyledons."—Henslow's *Dict. Bot. Terms*. A wide significance must be given to the word nut.

† "According to the doctrine of *epigenesis* no tissue, no organ pre-existed before its appearance; all are formed successively on the spot, and, so to speak, in all their parts. The individual nature of each animal rules and determines their composition and form. The theory of *evolution*, on the contrary, affirms that the germ contains in advance all the parts of the future being."—Quatrefages' *Metamorphoses de l'Homme et des Animaux*, p. 52.

"The difficulty is not to prove that, from one generation to another, changes of forms, sometimes considerable, may occur, as monstrosities, and many less striking anomalies, show this day by day. I assume, in fact, that a botanist somewhat accustomed to search for monstrosities, might find at least one example every day in the country; so that a thousand botanists might each year discover at least 365,000 monstrous growths. Small anomalies are frequent, and a complete similitude between two consecutive generations is rarer than monstrosities that are very distinct. Thus there arise under our eyes, without any intervention of man, and by operation of causes which we do not know, a very great number of forms, and of forms which are often so distinct that we should arrange them under new genera, and even under new families if they were persistent. Suppose that in Europe a single new specific form became prominent each year, a single new generic form once in ten years, and a single family form once in a hundred years, the European Flora would experience a greater change in a thousand years than in passing from the Miocene to the Pliocene, from the Pliocene to the Diluvium, etc.

"Thus the real difficulty is not the production of new forms, but in proving that the more or less aberrant forms that frequently arise propagate and preserve their peculiarity from time to time, so as to constitute, in the midst of ancient forms, new forms which are permanently hereditary. Mr. Darwin has placed his finger upon the essential point of this question in seeking a cause by which the variations from one generation to another necessarily become fixed, instead of disappearing according to the known laws of ancestry, by reason of fecundations imparted by individuals of the old form, or by an impossibility of nutrition, or by structural impotence to produce offspring. He considers he has discovered this cause in a 'natural selection' of forms which are most robust and best adapted to the external circumstances amongst which they arise, made at the expense of forms that are weaker, and whose adaptation gives them less resisting power. He lavishes, in support of his theory, accumulated observations, delicate and exact, on the habits of species belonging to both kingdoms, and on the complicated correlations which exist between individuals and varieties, and between vegetables and animals. He insists, more than was previously done, on the incessant struggle between organized beings, which limits their numbers in spite of boundless means of reproduction. It is here that he is most strong. He shows how the theory of evolutions is required to explain certain problems otherwise insoluble; for example, the existence of rudimentary organs, either useless or inconvenient for the individual, but which might have been useful to the

ancestors from whom they were inherited; the absence of certain species from countries so well fitted to them that they prosper when taken there, such as the horse in America, and the Erigeron Canadensis in Europe; the resemblance between the organized beings of one epoch, and those of an anterior epoch in the same part of the world: a certain uniform march which is observed in the succession of organized beings; and finally, the habitual juxtaposition of analogous species, that is to say, of the same genus, or division of a genus, in the same region, their frequent parcelling out (*cantonnement*) each in an island of the same archipelago, and the fact that they are not distributed throughout those countries which have now, and had at a former time, the same climate.

"The probability of a theory of evolution especially strikes those who do not believe in spontaneous generation, and who repudiate the idea that a blind or capricious creative force gave useless rudimentary teats to the males of the mammalia; appended to certain birds wings incapable of flight; supplied the bee with a dart, the employment of which causes her decease; furnished the poppy, and many of the Campanula tribe, with a capsule, whose dehiscence* occurs near the summit, and renders dispersion difficult; which added a downy tuft to the sterile seeds of many of the Compositæ, and denied it to fertile seeds, or only gave them a plume which fell off the seed instead of serving for its transportation. All these singularities—let us be plain, these defects—appear repugnant and embarrassing in the theory of a direct creation of forms such as we see them now, or as they existed at the Triassic or the Miocene† epoch; but it is quite otherwise with the theory of evolution. These inutilities or defects then assume the aspect of a heritage from ancestors who profited by them in consequence of a difference in their organization and surroundings. When an inherited peculiarity has become useless or mischievous, the species bearing it becomes extinct. Their original organization made them prosper in former time, it now causes their decline; just as certain great qualities in a people, or certain natural advantages which ministered to their interests in days of yore, sometimes become useless, or even so mischievous as to occasion their decay. The anomalies return under the dominion of a great law, and I find it natural that men whose ideas are far removed from materialism, such as Dr. Hooker, Asa Gray, and

* "Dehiscence (*dehisco*, to gape), the manner in which an organ, closed at first, ultimately bursts; but more especially applied when the bursting is with regularity along particular lines of suture, as in the anthers for the discharge of pollen; in many pericarps for the escape of seed."—Henslow's *Dict. Bot. Terms.*

† Trias is the name given by continental geologists to the New Red Sandstone series. Miocene is the middle Tertiary period.

Professor Heer, should prefer the theory of evolution, and attach themselves to studies that demonstrate its force.

"We must always distinguish the theory itself from demonstrations and deductions by means of which it is sought to establish it, and it is here that many naturalists, admiring the sagacity of Mr. Darwin, and the grandeur of his ideas, diverge from, or hesitate to follow him. If the theory of evolution be regarded as an hypothesis designed to explain important facts which do not admit of other elucidation, it seems to me eminently desirable, and it essentially takes account of the most obscure facts of natural history and palæontology; but on examining the proofs adduced in its support, even the very varied and ingenious ones of Mr. Darwin, I find them insufficient, and often contestable. Perhaps it may be said that grand hypotheses are considered realities in physics, although destitute of direct proof, on the ground that they explain all the facts that are known. Nevertheless, proofs are sought for, wished for, and discussed when produced. To this end physicists devise experiments, and make calculations; and naturalists, who cannot create living beings, nor perceive the origin of things, whether infinitely small or infinitely ancient, ought to observe facts, compare and weigh in their minds the value of indications and arguments of the most varied kind.

"Mr. Darwin's opinion, that a necessary and natural selection of the forms and qualities of individuals brings about a succession of different individuals in the lapse of time, is one of those new ideas which change the current of thought, because it assuredly has much truth in it and a considerable importance. The question is to learn whether there are other causes acting in an opposite direction, which Mr. Darwin may have neglected or underrated. He speaks, indeed, of ancestry, and of the breeding of ancient and numerous individuals with new and modified individuals, as leading back to pre-existent forms, but perhaps he does not assign to these influences all their power. Mr. Darwin, moreover, agrees that useful modification of species are rare, while many others are useless, and consequently transitory. One might object that, by a known law of the balance of organs and functions, when a useful modification exists in one direction, an opposite modification is developed elsewhere. Thus, one race of animals in which fat is caused to preponderate becomes unfit for reproduction. English horses, which are very swift in the race, cannot live in the open air of a rigorous climate; most of the vegetables, whose production of sugar or starch is forced, do not flower, as we see with the sugar-cane, or they contract diseases like the potato. Similar incidents probably affect wild species, but I do not insist upon them, fearing the reproach which has been directed against Mr. Darwin, that

he has too often drawn conclusions as to what must happen in nature from what does happen in domestication.

"We must agree with Mr. Darwin, whose frankness gives a pervading charm to his writings, that successive modifications of species by natural relation must be excessively slow, so much so, that for many thousands of years it would be impossible to perceive them. Practically, within historical periods we perceive nothing of it; on the contrary, a stability of form in certain species, and a constant susceptibility in regard to temperature, is demonstrated to have existed for three thousand years. The races of men instruct us on this matter. Assuredly, from the time of the ancient Hebrews, Greeks, and Romans, men of the white race have struggled with each other, both individually and collectively. The weakest, physically or intellectually, have always been at a disadvantage, while the strongest, physically and morally, have always carried the day; and yet we cannot say that, either in intelligence, beauty, strength, or health, there is any evident difference between the moderns and the ancients. . . . . Among modern societies, on which statistics have thrown great light, families and populations which receive the most intellectual culture become extinct faster than others,* and an excessive physical development has other pernicious effects. Thus the law of *balance*, of which I spoke, conducts to a sort of mean, in spite of successive acts of natural selection, whose existence I do not contest.

"The effect must be of indefinite slowness, as Mr. Darwin shows, and being controlled by other causes, often exceedingly active, its slowness is irregular. To this I have nothing to object, although the consideration of very prolonged periods of time makes varied impressions upon different minds. Not only does the idea of the infinite terrify us, as dominating a region which our mind cannot reach, but each one feels troubled when mention is made of durations which he is not accustomed to contemplate. A man without intellectural culture and historical knowledge finds his imagination confounded by a few hundred years; a few thousands produce the same effect upon an educated man to whom certain sciences are unknown, and millions are required to astonish the physicist or the geologist.

"The theory of evolution, and especially the Darwinian hypothesis, demands millions of years. We recoil, more or less alarmed, and reason justifies our instinctive fears. It tells us, in fact, that natural causes which man never witnessed, and which have no existence in his traditions, might have acted in

* We do not know where M. de Candolle finds statistics to show that the duration of life is shortest among the cultivated nations, or among their most educated classes.

very remote times in a manner which is unknown. Timidity is prudence in such a case."

The preceding extract from M. de Candolle suggests some important grounds of controversy with its author, but our object is to let him speak rather than to talk ourselves; and we lay it before our readers as an interesting contribution to those discussions which arise in all intelligent circles, and which every educated man carries on in the recesses of his own mind.

"PARASITE LARVÆ."

BY T. SPENCER COBBOLD, M.D., F.L.S.,

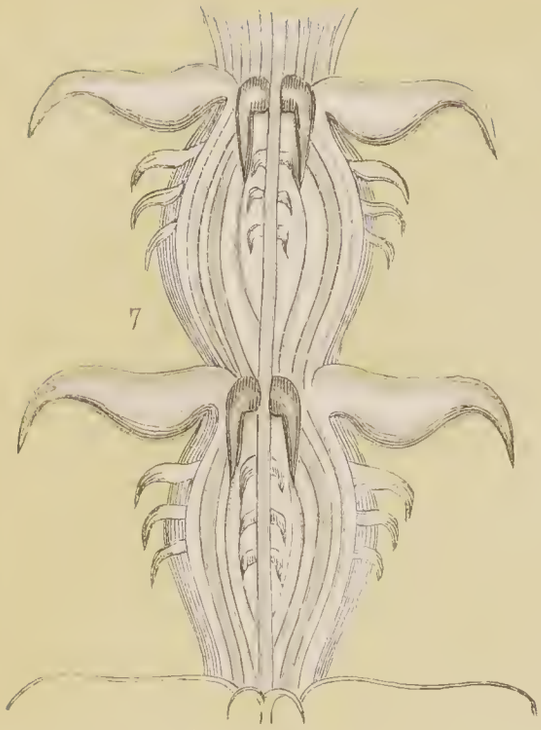
Lecturer on Comparative Anatomy, Zoology, and Botany, at the Middlesex Hospital Medical College.

MANY persons entertain erroneous notions respecting the habits and economy of those interesting creatures called tape-worms. A first attempt to look at them is often attended with a sensation of horror, whilst the act of handling them is seldom accomplished without a secret feeling of alarm. All this is very natural, and the mere idea of an animal, three or four times as long as the human body, taking up its residence within our own intestines is, certainly, not a very refreshing consideration; no, not even when it is accompanied with the kindly assurance of some benevolent friend that "it is for our good." At all events, we invariably feel justified in ridding ourselves of the unwelcome guest, and it deeply concerns us to know how we may effectually bar him out in future.

If the object of the present communication were to explain the very simple means by which we may avoid acting the part of "host" to the common full-grown tape-worm, we should have no difficulty in satisfying inquiries on this score; but, well knowing how much more obnoxious to animal life and comfort are the larval parasites referable to these same tape-worms or cestode entozoa, we deem it prudent to shelve, for the present, our consideration of the former, in order to throw light upon the structure, habits, and economy of the latter.

The cestode larvæ are much more common in occurrence than is usually supposed, and *they frequently cause death to man and the lower animals.* Here is our general proposition, the truth of which will be abundantly proven in the sequel; but, in the meanwhile, by way of introduction, we invite attention to the organization of a comparatively harmless larva which developes itself in the salt-water fishes.

Sharks and skates are copiously infested with tape-worms of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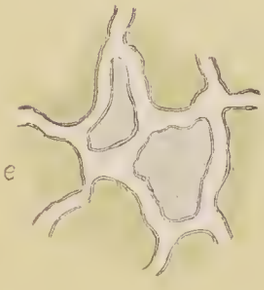
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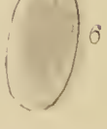
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a peculiar construction, and to such cestodes the illustrious parasitologist Rudolphi applied the generic title of *Rhyncobothrium*. These rhyncobothria are now known to be mature tape-worms, whose larvæ had been previously regarded as distinct species under the generic title of *Tetrarhynchus*. For simplicity's sake we retain the latter title in place of the former, having already employed this title when describing a remarkable example of sexually immature tetrarhynchus in former pages of the INTELLECTUAL OBSERVER (vol. 2, p. 82). We shall also make use of Prof. Van Beneden's term "scolex" to specialise those larvæ, the heads of which resemble those of the adult or parent form. These scolices, then, are merely larval tape-worms, those belonging to the genus tetrarhynchus being particularly abundant in marine fishes, such as the cod, haddock, turbot, sole, and flounder; they are likewise found in the mackerel, mullet, gurnard, conger, sun-fish, and even, according to Von Siebold, in the cephalopodous molluscs or cuttle-fishes.

The accompanying plate illustration represents a scolex of tetrarhynchus removed from the wall of the intestine of a common haddock. It was associated with several other larvæ of the same kind, varying in size from a pin's head to that of a pea. Each young tetrarhynch was enclosed in a thick-walled sac, such as is displayed in figs. 1 and 2, the latter representing the sac burst open, and magnified four diameters linear. Fig. 3 gives a general view of the scolex, which is inverted and enclosed within the bladder-like vesicle—the latter being, in point of fact, the tail. The four long filamentary proboscides are also seen here, and also the little highly-refracting dots, which represent what are termed "calcareous corpuscles." The transverse lines are caused by the regular folding of the vesicles. Fig. 4 shows the head and neck of the natural size, everted. Fig. 5 is another view of the anterior end of the same, amplified about twenty diameters. It exhibits four narrow, pointed, sucking appendages, at the base of each of which is an open papilla, giving passage to one of the retractile proboscides or tentacles. These organs are armed with a complicated series of spines or hooks, but whilst lodged within the neck are embraced by a strong tubular and muscular sheath, which at the lower part is club-shaped, so as to form what has been termed the "lemniscus;" the figure (5) also shows a portion of the large caudal vesicle, with the calcareous corpuscles *in situ*. Fig. 5*e* represents a small portion of the wall of the neck, displaying a fine network of capillary tubes beneath the skin (× 260 diam.). Fig. 6 is an isolated sclerous or calcareous particle greatly enlarged; fig. 7 being a section of one of the retractile proboscides, showing the relative size and disposition

of the hooks (× 200 diam.). The retractor muscle of the proboscis is represented in fig. 8. From these facts it will be seen that each proboscis is, as it were, composed of numerous spurious segments, every division supporting quadruple rows of four hooks, sixteen in all, the superior set being disproportionately large; so that, in any one individual scolex, the total number of spines must amount to several thousand. These organs are employed as instruments for boring through the flesh and tissues of the host, the larvæ being thus furnished, as it were, with four chain saws, whose efficiency and adaptiveness is greatly increased by the circumstance that each chain presents four serrated edges, the teeth of which are, moreover, of four different sizes. Such an arrangement as this is sufficient to excite our astonishment. Not a few tetrarhynchi exhibit even a still more complex armature of the proboscides, as may be seen, for example, in the *T. longicollis*, infesting the tope or penny-dogfish (*Galeus vulgaris*). This, and many other closely-allied cestodes, are beautifully figured by Van Beneden in his *Recherches sur les vers Cestoides.*

From what has thus been advanced concerning the prevalence and variety of these scolices in marine fishes, it will at once be conjectured that the sharks and rays—whose diet does not appear to be restricted to one or two particular fishes only—will be liable to infest themselves with a great variety of tape-worms. This conjecture is, indeed, entirely supported by ascertained facts; for we find the angel-fish (*Squatina Angelus*) infested by at least four different cestode species, whilst the common thornback (*Raia clavata*) rejoices in the distinguished honour of being permitted to entertain, as tolerably constant guests, no less than eight distinct forms of tape-worm, belonging to the genera *Onchobothrium, Tetrabothrium, Tetrarhynchus,* and *Tetrabothryorhynchus!*

All these mature tape-worms, however, as before hinted, are harmless occupants when compared with the cestode larvæ which some of their congeners produce. Possibly, the sun-fish may wince a little when his liver is being bored through and tunnelled by an immature *Tetrarhynchus reptans,* and the sharks and rays would, in all likelihood, feel more comfortable after taking a good vermifuge; but when a scolex of the common tape-worm (*Tænia solium*) gets into the human brain, we are in a far worse plight than our piscine friends,—in short, "it is all up with us." Seriously, it may be asked, do young tape-worms or scolices ever get into our heads; and, if they do, under what circumstances are they permitted to enter? In reply, we answer the former question affirmatively, but the easy solution of the latter must be allowed to stand over.

Several entozoologists, including the illustrious Rudolphi,

have found the scolex commonly known as the "pork meazle" (*Cysticercus telæ cellulosæ*) lodged in the human brain, whilst cases of its occurrence in the eye of man have been recorded by Soemmering, Cuvier, Larrey, Schott, Mackenzie, Rose, and many others. Occasionally, in instances where the scolex has caused death, such cases have been described, not only in the medical journals, but even in the public newspapers. Through the vigilance of a relative an example of the latter kind was not very long ago brought under our notice, and, as the case in question admirably illustrates the subject under consideration, we subjoin an abridged statement, omitting the *days* mentioned, as neither the monthly nor precise yearly date of its report is at present in our possession. The passage stood nearly as follows :—

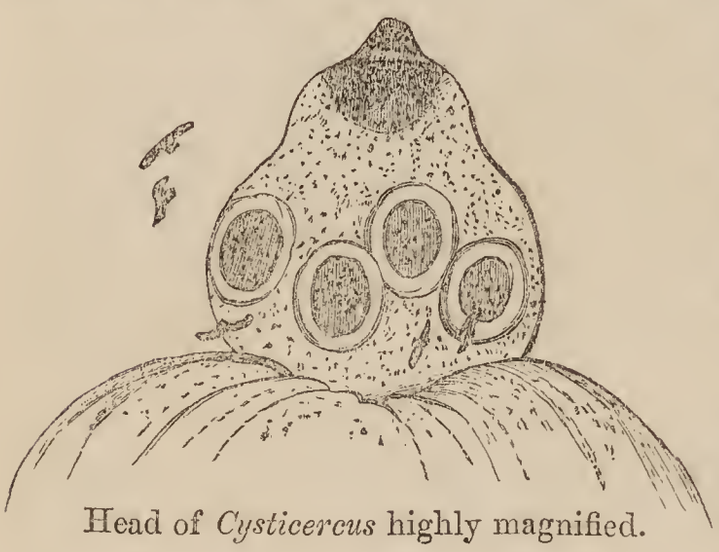
Extraordinary Death from a Worm in the Brain.—An inquest was held at the Walsall Workhouse, before the coroner, Mr. Fletcher, on the body of Rachel Brady, twenty years of age, an inmate of the house, who was found dead in bed. On her admission she complained of pain in her head, and was treated for it by the medical officer, Dr. Burton. This gentleman, in giving evidence of the conditions he had discovered in course of making the *post mortem* examination, stated that in the *tuber ancillare*, at the top of the spinal marrow, there were four hydatid sacs or *cysticerci* (*telæ*) *cellulosæ*. These conditions, he considered, were sufficient to account for the suddenness of the death of the deceased, and he had ascertained that it was not uncommon for her, when alive, to eat sausages. He had no doubt the hydatid sac was composed of the egg of the tapeworm, the parasite having been taken into the body in the process of eating sausages not properly cooked; this food being prepared from measled pork. The jury returned a verdict of "Disease of the Brain."—*Staffordshire Advertiser.*

This case is very instructive, and we are privately informed by Dr. Burton that an account of it was also subsequently reported in one of the medical journals, the date of which he is unable to supply. The newspaper reporter is not quite correct in stating that "the sac was composed of the egg of the tapeworm," because helminthologists have satisfied themselves that these hydatid scolices are formed by the growth (and alteration in form and character) of the embryo after its escape from the egg. Under the microscope, the scolex or hydatid displays a head, neck, and vesicular *body*, improperly so called, as the latter sacciform portion is, strictly speaking, the caudal vesicle or tail.

In the accompanying cut we have an illustration of the same species of *Cysticercus*, taken from a specimen preserved in our collection. This individual scolex was found with several

others snugly ensconced in the brain of a man whose death their combined presence served to occasion.

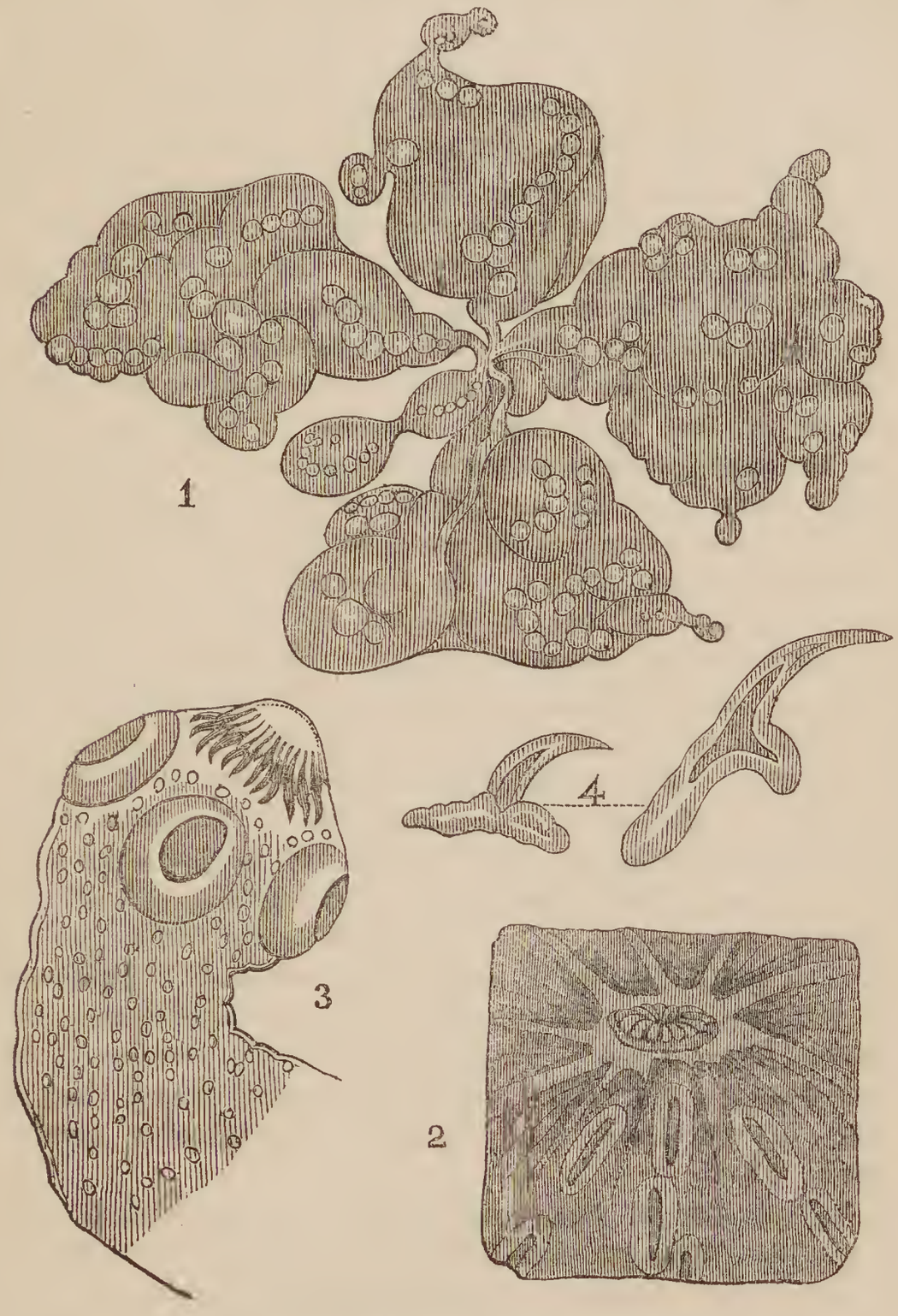
For possession of the specimen we are indebted to the kindness of J. W. Hulke, Esq., F.R.C.S., from whose notes of the case we gather that the poor fellow suffered from epileptic fits, the disease being entirely due, in this instance, to the presence of these scolices. If more examples of the kind were required, it would not be difficult to produce them from the records of medical literature; and we may also mention that a third example of *Cysticercus telæ Cellulosæ* from the human brain was some time ago presented to the Hunterian Museum of the Royal College of Surgeons. Whatever their frequency in occurrence, it is quite clear that when the scolices have once settled down in our brains, all attempts to get rid of them—even if we knew that they were there—must prove futile. Unfortunately, too, other kinds of scolex are liable to play the same disastrous tricks with us, even in the brain, so that although we may escape death by the invasion of *Cysticercus*, we may nevertheless fall a prey to the wiles of the more abundant *Echinococcus*. Alas! for the dignity of human nature, we succumb to the self-seeking propensities of a larval parasite, whose body is barely visible to the naked eye.



Head of *Cysticercus* highly magnified.

We now pass to the consideration of a larval tape-worm which occasioned the death of a Madagascar Lemur (*L. maco*), formerly living in the Zoological Society's menagerie, Regent's Park. This scolex, by examining the figures given in the annexed cut, will be found to differ, not only from those already described, but also from all other known forms of parasite larvæ. Its nearest ally is the well-known hydatid (*Cœnurus cerebralis*) which infests the brain of sheep, giving rise to the formidable and occasionally fatal disease known as the "staggers." In fact, we have here a second kind of *Cœnurus*, in which, as in the common species, the scolices are associated in a colony, but, instead of occurring as separate and independent cysts, each supporting numerous tape-worm heads, we find the *Cœnurus* of the Lemur forming several cysts connected by narrow peduncles (fig. 1). The hydatids from the Lemur were not found in the brain, but occurred in such numbers in the liver and on both sides of the thorax, that they proved as destructive to the life of the host as if they had infested the cere-

bral organ. Those in the chest were connected to the lining membrane of the lungs, forming semi-transparent pedunculated cysts, split up, as it were, into numerous lobules, the entire mass being connected to the extremely atrophied lungs by short pedicles. Here and there small colonies, consisting of



COLONY OF CÆNURUS FROM A LEMUR.

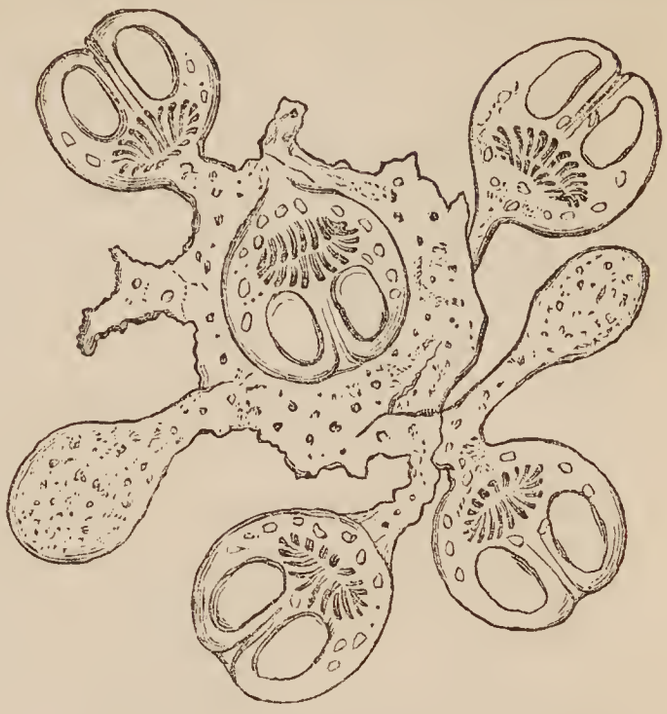
one or two vesicles only, were seen in process of development. Each lobulated cyst presented a variable number of small round papillary elevations, which in some places assumed a regular linear arrangement. Under a low magnifier the surfaces of the papillæ exhibited a central oval depression externally (fig. 2), and in the fully developed condition they were found to con-

tain perfect tape-worm heads. Each cyst or hydatid is, therefore, to be regarded as a compound scolex, every individual head of the colony representing an immature cestode, with its four characteristic suckers, central proboscis, and double crown of hooks (fig. 3 ; × 40 diam.). The two rows of the latter, sixteen to the row, present the usual disparity of size, their manifest differences, in bulk and outline, being shown in fig. 4 (× about 250 diam.). No loose scolices, or separate heads, could be found in the cysts, which only contained a clear pale-yellow fluid. This last-mentioned circumstance shows that the hydatid of the Lemur is quite distinct from the *Echinococcus*, although in its place of residence it corresponds more closely with the latter than it does with *Cœnurus*. As yet we are ignorant of the adult *Tænia*, to which this curious larva is referable.

The next larval parasite which naturally demands our consideration is, in so far as it affects our welfare, the most important of all the tape-worm scolices. Disastrous as are its ravages amongst various animals, to none of these does it prove so injurious as it does to our fellow-creatures dwelling in Iceland, whilst even amongst ourselves in England its death-dealing invasions are not unfelt. In Iceland it is calculated that about one-seventh of the population who die annually, perish solely from the Echinococcus disease. Startling as this result may appear, it only affords a very imperfect estimate of the actual mischief this minute scolex is capable of effecting. For some time past, helminthologists have sought to discover the best methods of checking the prevalence of this much-dreaded malady ; but although we are pretty well acquainted with the migrations and genetic changes of the species, we are hardly in a position to do more than suggest a partially preventive remedy. A great variety of animals are subject to Echinococcus disease, but we can only select one or two examples, for the purposes of illustration. The literature of the subject is also of immense extent ; the last important memoir being that of Dr. Naunyn, in Reichert and Du Bois Reymond's *Archiv* for November, 1862.

In the month of February, 1861, we received a mass of Echinococcus cysts, procured from a second Lemur, which died at the Zoological Gardens. A small group of the scolices, or heads, are here represented (× 130 diam.). If these little scolices be closely examined, they will not be found to differ materially from those occurring more frequently in our domesticated animals, nor, indeed, have we been able to discover any essential difference between them and the *Echinococci* infesting the human body. Kuchenmeister, we are aware, thought he had made out two distinct forms, but Professor Leuckart, of Giessen, has satisfactorily demonstrated the erro-

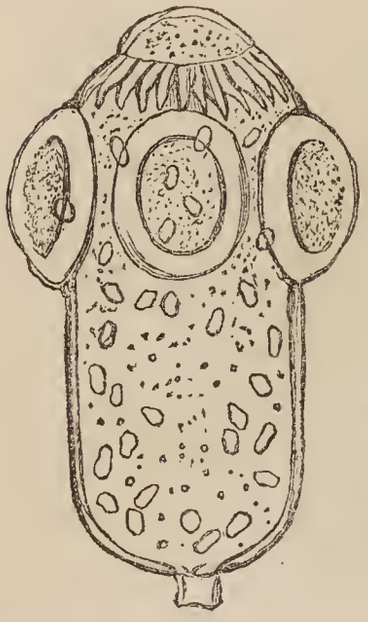
neousness of Kuchenmeister's views. Moreover, on continuing the investigation, we have satisfied ourselves that the two reputedly distinct forms are identical. In the group here figured all the perfectly developed scolices have their heads invaginated within their own bodies, the crowns of hooks and the suckers being for the most part viewed in profile. The calcareous corpuscles are distinguishable from the ordinary granules of the endocyst (from which the scolices bud) by their comparatively large and more uniform size. Two of the pedunculated buds are imperfectly developed.



Brood of *Echinococcus:* Lemur.

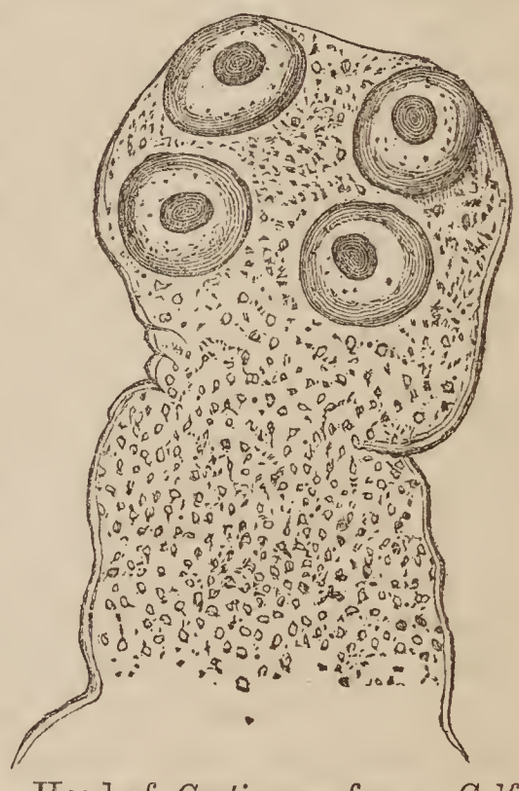
As already stated, the Echinococcus disease occurs in this country; but in the Registrar's Reports one never sees any statement as to the number of persons who die of parasitic disease. Of course not. Many cases are altogether overlooked, and even in those which are taken notice of, the death is attributed either to a "disease of the brain," or of the liver or lungs, as the case may be, although these organs may be altogether free from any structural disorganization, apart from that immediately occasioned by the mechanical pressure in the neighbourhood of the Entozoon. Instances of the kind have come under our notice, as, for example, in the case, ably reported in the *Lancet* for November 1st, 1862, where a poor girl died in one of our metropolitan hospitals from *Echinococci*, which had taken up their abode in her liver; and, as also in Dr. J. Risdon Bennett's case (given at p. 5 in the recently published 13th vol. of the *Pathological Transactions*), where another person perished from *Echinococcus* which infested the brain. Annexed is a figure of one of the scolices from a liver-cyst in the former case; and in all essential points it will be found to agree with those figured from the Lemur. In this case, however, the head is everted, so as to display the four suckers (× 260 diam.). Of course the medical profession know very well that such cases as the above are referable to Entozootic disease, but the public are very ill-informed, if not altogether ignorant, of the prevalence and destructive powers of the Entozoa. It may be thought unkind to dispel that "ignorance which is bliss," but unless some person duly conversant

with these parasites be instructed to report upon them, not a few more men and animals will continue to perish, several of which might probably have been saved by preventive remedies. Our experimental investigations into the development and migrations of these creatures are not unattended with personal risk, though that risk is doubtless far less apparent than that of the intrepid voyager who, in the interests of science and humanity, leaves the earthly globe six miles behind.



Human *Echinococcus.*

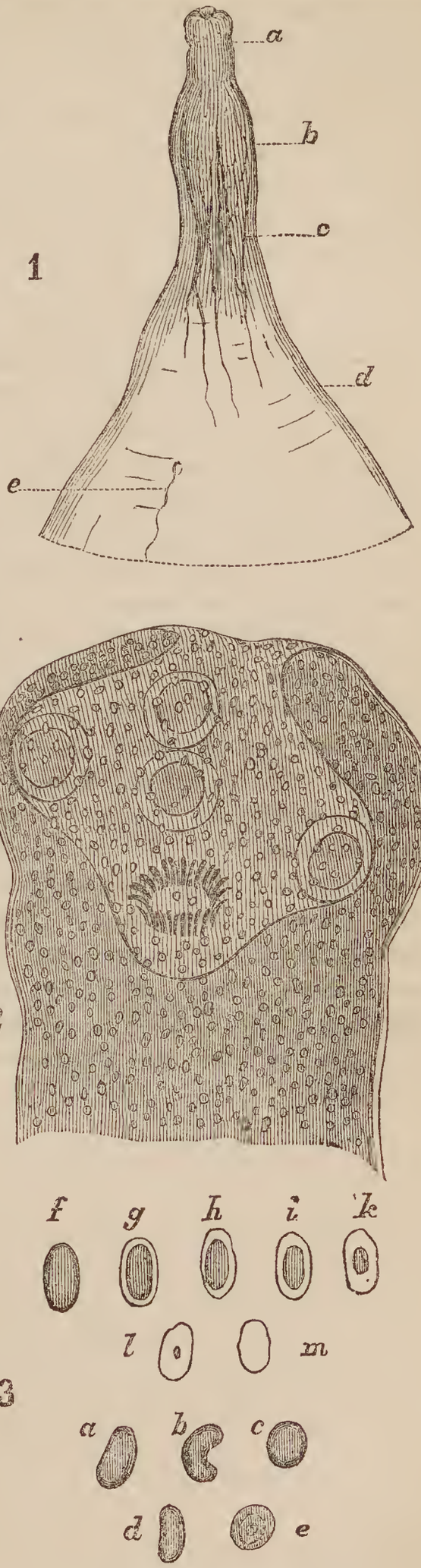
Another larval parasite of considerable interest is that occurring in veal or beef, and which, when swallowed by ourselves, will give rise to a tape-worm, delighting to embrace the favourable opportunity of residing within our intestines. The cestode in question (*Tænia mediocanellata*) is not the common tape-worm, but is one very frequently mistaken for it, and is, in all likelihood, not much less abundant. Its discovery in the adult condition as a distinct species is due to Dr. Kuchenmeister, but for our knowledge of the larval state we are principally indebted to Prof. Leuckart, of Giessen. The head and neck of this *Cysticercus* (or scolex of the *Tænia mediocanellata*) is represented in the accompanying cut (× 30 diam.), from a specimen presented to the writer by the distinguished helminthologist last named. The scolex is about twelve weeks old, that is to say, it was artificially bred in a calf, from the eggs of a tape-worm, given with food to that animal twelve weeks previously. The adult cestode or tape-worm is readily distinguished from the common *Tænia solium* by its not possessing any crown of hooks, and by other characters only a little less conspicuous.



Head of *Cysticercus* from a Calf.

The last larva to which we invite attention is the well-known hydatid of the caul (*Cysticercus tenuicollis*). This scolex not only infests our domestic cattle, but it has also been found in man, and in various wild animals. It is the juvenile condition of a tape-worm (*Tænia marginata*) living in the intestines of the dog. The scolex here figured was

taken from a female Red River hog (*Potamochœrus penicillatus*) which died at the Zoological Society's Gardens. There were, indeed, five specimens, all of which exhibited a more or less oval outline. Fig. 1 shows only the neck (*a*), the body (*b*), numerous rope-like coils hanging within from the inverted head (at *c*), a portion of the enormously-developed caudal vesicle (*d*), and a small thread-like filament suspended from the inner surface of the latter (at *e*). The head itself, being lodged within the upper part of the neck, was only detected by careful dissection, and when placed under an inch objective was found to display the usual four sucking disks, surmounted by a coronet of hooks (fig. 2). The margin of the neck was bordered by a double contour, the parenchymatous substance being everywhere studded with a multitude of calcareous corpuscles, the latter not being limited to the neck, but existing also in the head. These so-termed calcareous, or, as we prefer to call them, "sclerous," corpuscles from this *Cysticercus ex Potamochœro penicillato* were examined with especial care. When viewed with transmitted light, they impart to the tissues a dark pigment-like hue, which is merely owing to the shadows caused by their highly refracting properties. They were much more numerous than the accompanying figure (2) indicates, for, indeed, it would be almost impossible to represent their numbers in a drawing, without imparting to the illustration a very



CYSTICERCUS TENUICOLLIS.

confused appearance. Their general disposition and relative size, however, is fairly indicated, and (in fig. 3) some of them have been highly magnified (220 diams.) Their form is commonly that of spherical, or oval, flattened disks (*f*, *c*, *e*,); but not unfrequently they are elongated, occasionally thicker at one end than the other (*a*, *d*), and sometimes reniform (*b*). All are bordered by an opaque margin; and they often display evidences of concentric lamination, the rings resembling nuclei and nucleoli (*e*). In respect of size they do not vary materially, having an average length of $\frac{1}{1400}$ to $\frac{1}{1000}$, and a breadth of from $\frac{1}{2000}$ to $\frac{1}{1400}$ of an inch. On the addition of diluted sulphuric acid, a rapid effervescence took place, accompanied with the total destruction of the corpuscles; but the alkaline reagent (*liquor potasse*) caused only a gradual dissolution of the enveloping membrane, leaving behind a perfectly transparent and thin calcareous plate, unpossessed of any appreciable light-refracting properties. The last-mentioned change proceeded uniformly from without inwards; the corpuscle (*f*) presenting in succession the appearances indicated (at *g*, *h*, *i*, *k*, *l*, and *m*) in the figure; the last (*m*) is the isolated calcareous plate, whose circumferential border has lost that entire smooth outline which the unaltered corpuscle invariably exhibits.

Limitation of space forbids our entering upon the curious question still raised in respect of the function of these bodies; but on the whole it may be said that Von Siebold's idea (that they are analogous to the "spicules and calcareous networks" strengthening the integument of Echinoderms) has gained a more general acceptance than any other theory. Those who desire further particulars on this point are invited to refer to the writer's previous paper, in the Zoological Society's Proceedings (Vol. XXIX, p. 93), and also, especially, to Prof. Huxley's memoir on Echinococcus in the same work, for the year 1852.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. CHAMBERS.

(*Continued from page* 383, *Vol.* ii.)

153. In February, a comet appeared in the W.—(De Mailal, ii. 571.)

147. A comet appeared in May in the North-west, and lasted three weeks.—(Ma-tuoan-lin; De Mailla, ii. 584.)

146. "After the death of Demetrius, King of Syria, the father of Demetrius and Antiochus, a little before the war in Achaia, there appeared a comet as large as the sun. Its disc was at first red and like fire, spreading sufficient light to dissipate the darkness of night; after a little its size diminished, its brilliancy became weakened, and at length it entirely disappeared."—(Seneca, *Quæst. Nat.* vii. 15.) It lasted thirty-two days.—(Jul. Obseq.)

137 [i.] "In the reign of Attala, a comet was seen which, small at first, afterwards became much larger. It reached the equinoxial circle, and equalled in length that part of the heavens which is called the Milky Way."—(Seneca, vii. 15.) From Ma-tuoan-lin's account it would seem more likely that this comet reached the Milky Way not by its length, but by its motion. It appeared in March.

137 [ii.] A comet appeared two months after the preceding, which passed from ε Herculis to α Lyræ.—(Ma-tuoan-lin.)

137 [iii.] A comet was seen in the autumn in the North-west.—(Ma-tuoan-lin; De Mailla, iii. 9.)

134. At the birth of Mithridates a comet appeared, and lasted seventy days; the heavens appeared all on fire; the comet occupied the fourth part of the sky, and its brilliancy was superior to that of the sun; it took four hours to rise, and the same to set.—(Justin. *Hist.* xxxvii. 2.) There is very great uncertainty about this comet of Mithridates, but Pingré, after considering Ma-tuoan-lin's account, is almost certain that 134 is the year. He also says that probably it appeared in the middle of July in the West; before the end of August it would have been lost for a few days in the sun's rays, when probably the P.P. took place. It would then have re-appeared with increased brilliancy early in September in the East, and so have passed away from the sun.—(*Comét.* i. 270, 578.)

127. A burning torch appeared in the heavens.—(Jul. Obseq.)

119. A comet was seen in China in the East.—(De Mailla, iii. 46.)

118. When Mithridates ascended the throne, there appeared during sixty-six days a comet exactly resembling that which was seen at the birth of that monarch.—(Justin. xxxvii.) It came from the North-west in May.—(Ma-tuoan-lin.)

109 [i.] A comet was seen in the feet of Gemini in the month of June.—(Ma-tuoan-lin; De Mailla, ii.; 61.)

109 [ii.] This comet appeared contemporaneously with the preceding, in the constellation Ursa Major.—(Ma-tuoan-lin; De Mailla, ii. 61.)

108. A comet appeared in the region lying between Procyon (α Canis Minoris) and α and β Geminorum.—(Ma-tuoan-lin.)

102±. A comet was seen in China near γ Boötis.—(Ma-tuoan-lin.)

93. A torch appeared in the heavens.—(Jul. Obseq.)

91. A torch appeared in the heavens.—(Jul. Obseq.)

86. A comet was seen in autumn in the East.—(De Mailla, iii. 98; Plin. ii. 23.)

83. A comet was seen in the spring in the North-west.—(De Mailla, iii. 101.)

75. "In the Consulate of Cn. Octavius and C. Scribonius, a spark was seen to fall from a star; it grew larger as it approached the earth, and became equal in size to the moon, and gave as much light as the sun gives during the day time when the sky is entirely covered. In returning into the heavens it took the form of a *lampas* [torch.]"—(Plin. ii. 35.) This description may be fairly taken as applying to a comet, though the wording is very obscure.

62. A burning beam stretched from the Western horizon to the zenith.—(Jul. Obseq.) Torches ran from the West to the middle of the sky.—(Dion. Cass. *Hist. Roman.* xxxvii.) A comet appeared in the East in the 6th Moon.—(De Mailla, iii. 136.) Dion. Cassius's allusion is very doubtful; and whatever may be the date of the burning beam, it is probable that De Mailla's comet must be referred to 61.

55. A torch appeared which advanced from the South to the North.—(Dion. Cass. xxxix.)

52. A torch appeared which passed from the South to the East.—(Dion. Cass. xl.)

48. During the war between Cæsar and Pompey, "a comet (that terrible star which upsets the powers of the earth,) showed its portentous hair."—(Lucan, *Phars.* i. 526.) In the 3rd Moon a comet was seen near β Cassiopeiæ; passing by ι in that constellation it became lost in the circumpolar regions.—(De Mailla, iii. 155.)

43 [i.] A comet was seen in China in May—June, whose Right Ascension was the same as that of Orion.—(De Mailla,

iii. 162.) It came from the North-west, its tail was very long and pointed to the North-east.—(Ma-tuoan-lin.)

43 [ii.] A hairy star was seen for seven days under the Great Bear during the celebration of the Games given by the Emperor Augustus in honour of Venus. It rose at about five in the evening, was very brilliant, and was seen in all parts of the earth. The common people supposed that the star indicated the admission of the soul of Julius Cæsar into the ranks of the immortal gods.—(Suet. *Vit. Jul. Cæs.*) It was visible therefore from September 23 to September 29.

Dion. Cassius says that in addition to the comet which appeared contemporaneously with the emperor's games, there was seen a burning torch which traversed the heavens from East to West; and also an unknown star, which shone for many days.—(*Hist.* xlv. 17.) Pingré thinks the former was simply a meteor, but that the latter was that which was seen in China, and recorded as having been a comet.—(*Comét.* i. 278.)

42 or 41. Previous to the battle of Philippi, comets appeared.—(Virg. *Geor.* i. 488; Manilius, *Astron.* i. 904.)

31. A torch appeared in February for several days.—(Dion. Cass. l.; De Mailla, iii, 178; Ma-tuoan-lin.)

29. Before Egypt submitted to Augustus, there appeared comets.—(Dion. Cass. li.) Lubienitzki (a modern writer) says that a comet appeared for ninety-five days in Libra, but gives no authority.

4. At the Vernal Equinox a comet appeared for seventy days in the head of Capricornus.—(De Mailla, iii. 214.)

3. In April or May a comet appeared near α Aquilæ, to the north of Capricornus.—(De Mailla, iii. 214.) Probably the same as the preceding, but one year wrong in the date.

A.D. 10. Several comets visible at the same time.—(Manilius, i.; Dion. Cass. lvi. 24.) Some modern cometographers state that one appeared in Aries for thirty-two days.—(Lubienitzki.)

14. Hairy stars of the colour of blood.—(Dion. Cass. lvi, 29.) A comet was seen in China for twenty days, either at the end of 13 or the beginning of 14.—(De Mailla, iii. 240.)

19. A comet was seen in China.—(Couplet.)

22. A comet was seen for five days in December. It was in Hydra, and moved in a S.E. direction.—(De Mailla, iii. 251; Ma-tuoan-lin.)

39. A comet became visible on March 13 in the Pleiades; it moved in a N.W. direction through Aries, towards α and β Pegasi. It remained visible forty-nine days.—(De Mailla, iii. 326; Ma-tuoan-lin.)

54. A comet appeared for a long time, in the autumn (?) It was first seen in the N.; it moved to the zenith, and thence

eastwards, and day by day its brilliancy diminished.—(Dion. Cass. lx. 35; Suet. *In. Claud.*)

55. A comet appeared in November 55, and remained visible for 16 weeks, or till March 56. When first seen it was 2° long; it moved towards the S.W., and disappeared on March, 26, 6° N.E. of γ, δ, η, θ Cancri.—(Gaubil.)

60. A comet, with a tail 2° long, appeared on August 9, to the N. of η, γ, α, and δ Persei. It remained visible for 19 weeks, and passing southward, disappeared S. of the feet of 326; Virgo.—(Tacitus, *Annal.* xiv. 22; De Mailla, iii. 352; Ma-tuoan-lin.)

61. On September 27, a strange star was detected to the N.W. of ρ Boötis, with a tail pointing towards Corona Borealis. After seventeen days it quitted this position, but we are not told whither it went.—(Ma-tuoan-lin; Seneca, vii. 28.) It is uncertain whether the comet seen in China is the same as one spoken of by Seneca.

64 (i.) On May 3, an extraordinary star, with a vapour 2° was seen to the S. of η Virginis, and lasted eleven weeks.—(Gaubil.)

64 (ii.) A comet appeared at the end of this year, in the reign of Nero, and lasted six months. It passed from the N through the W. to the S.—(Seneca, vii. 21, 29; Tacit. xv. 47 Suet. *In Nerone.*)

65. On July 29, a great star was observed near δ and η Hydræ; it approached α and γ Leonis, and passing α and γ Persei, arrived near β Leonis (?) The vapour extended to ι and κ Ursæ Majoris; it remained visible eight weeks.—(Ma-tuoan-lin.)

69. A comet appeared sometime between April and December.—(Dion. Cass. lxv. 8.) Possibly this may be the object referred to by Josephus as having been seen over Jerusalem before its destruction by Titus.—(*Bell. Jud.* vi. 5.)

70. A strange star appeared in the head of Leo in December 70 or January 71. It remained visible for seven weeks.—(Gaubil.)

71. On March 6, a comet appeared in the Pleiades; after eight weeks it was seen to the right of the head of Leo, and then vanished.—(Gaubil.)

75. On July 14, a comet was discovered in Hydra; moving to the south of Coma Berenicis, it passed to the vicinity of β Leonis.—(De Mailla, iii. 375.)

76. On September 7, a comet, with a tail 3° long, was seen between α Herculis and α Ophiuchi, whence it passed to Capricornus. It remained visible for six weeks, and travelled slowly.—(De Mailla, iii. 376; Ma-tuoan-lin; Pliny, ii. 22.)

77. On January 18, a comet, with a tail 8° or 9° long,

appeared in the R. A. of Aries, whence it moved to the tail of Draco. It remained visible for fifteen weeks.—(Ma-tuoan-lin; Gaubil.)

79. In the spring (?) a comet was visible for a long time, during the illness of Vespasian.—(Dion. Cass. lxvi. 17; Suet. *In Vesp.*)

84. On June 4, an extraordinary star 3° long appeared in the eastern heavens. Its R. A. was 8° greater than μ^2 Scorpii. It passed near α Cassiopeiæ into the circle of perpetual apparition, remaining visible six weeks.—(Hind.)

101. On December 30, a new star appeared in the head of Leo. As no mention is made of any change of position, it may have been merely a temporary star.—(Hind.)

104. On June 10, a new star appeared in the circumpolar regions; it passed to the Pleiades, and vanished in the next moon.—(Hind.)

VEGETABLE HYBRIDS.

In recommending that a memoir by M. Naudin, on the above subject, should receive the "grand prize for the physical sciences," the commission of the French Academy made the following interesting remarks on that gentleman's researches :—

"His conclusions tend to a profound modification of the ideas admitted by the majority of physiologists respecting the conditions which regulate the production of hybrids. The first and most important is, that the singular beings which result from the cross fecundation of two different types, far from being condemned to absolute sterility, are frequently endowed with the faculty of producing seed capable of germination. Out of from thirty-eight to forty hybrids of species obtained by M. Naudin, and described in his memoir, only nine, or possibly ten, appeared to be completely sterile. All the rest, forming three-quarters of the entire number, produced seeds which germinated perfectly. These fertile hybrids belonged to the genera Primula, Datura, Nicotiana, Petunia, Linaria, Luffa, Coccinea, and Cucumis. A serious objection might be raised against this conclusion, which is so little in harmony with the general belief introduced into science by Köhlreuter, and adopted by Knight, Klotzsch, etc., it is that the fecundity of the hybrids, obtained by the author, was due to the action of the pollen of one of their progenitors, and not to that furnished by themselves. But this objection breaks down before the important fact that the hybrids were isolated from their parents, and could only be fecun-

dated by themselves. This fecundity of a great number of hybrids is exhibited in different degrees, but it is usually related to the proportion of normal pollen grains which the microscope discovers in the anthers of the plants.

"The second consequence of major interest which results from the numerous experiments described in the memoir, is that fecund hybrids have a tendency to return to the parent form, and that without any other action than the influence of their own pollen, in such circumstances that the pollen of their parents could not possibly operate upon them. If this principle be sufficiently established by our author—and it does not seem possible to consider otherwise in the presence of the numerous facts and conclusions upon which it rests—there can no longer be a question concerning those bold theories according to which the number of vegetable forms permanently transmissible by generation, that is to say, of species, may increase indefinitely from day to day by means of hybridation."

Upon this passage we may remark, that the *tendency* to return to the parental type is proved by the evidence of the facts, that in both the animal and vegetable worlds species have an undoubted persistance in time, although fertile hybrids are much more common than was formerly supposed. The French commission do not, however, seem disposed to avoid the logical error of premature generalization; and if their remarks are directed against Darwin's theory, we may remind them that its author does not, in the words of Sir C. Lyell, "regard hybridization as a cause of new species, but rather as tending to keep variation within bounds."

The members of the commission proceed to inquire whether the fecundity of hybrids is proportioned to the external resemblance of the species which produce them, and they tell us that the memoir replies, "in general, yes; but in exceptional cases, no. In fact, experiments with closely allied species, of Datura, Nicotiana, and Cucumis, have furnished examples in which mutual fecundation was difficult, or hybrids sterile; while, on the contrary, species botanically remote from each other have yielded very fertile hybrids with remarkable facility."

"Lastly, a fourth question relates to the organ which determines the sterility of infecund hybrids. For a century the observers who have examined sterile hybrids have noticed an habitual deficiency of pollen in such plants; but they experienced more difficulty in distinguishing a vicious conformation in the pistil. One of them, Klotzsch, even thought himself justified in asserting that sterility is never due to the imperfection of the latter organ. The author of the present memoir has made this portion of the subject a matter of attentive study—direct so far as the pollen is concerned, and indirect

as relates to the pistil. With reference to the pollen he has confirmed what was already known, and with regard to the pistil he has concluded, from divers observations, that the exterior parts of that organ are ordinarily well formed, and that we must sometimes seek in the imperfection of the ovule the cause of sterility. We regret that time failed for sustaining this opinion by the help of the microscope.

"Not content with replying by experiment to the numerous questions put by the Academy, he has endeavoured to throw light upon divers points, some obscure and others not yet studied in the history of hybrids. He has confirmed what was known to Sageret, namely, that in a hybrid the character of its two factors were often seen, not confounded, but brought near; as for example, that the fruit of a hybrid Datura, born of two species, one having a smooth and the other a spiny capsule, presents smooth surfaces in the midst of a surface generally spinous. This *disjunction*, as he terms it, he explains by the presence in the hybrid of two specific essences, which tend to mutual separation more or less rapidly. He sees even in this disjunction the veritable cause of the return of fertile hybrids to the specific types from whence they proceeded. He has, moreover, established a fact not previously suspected, that the pistil of a plant can at one time undergo a legitimate fecundation and a crossed fecundation, that is to say, two fecundations, simultaneous and distinct, so that the fruit produced may contain both normal and hybrid seeds. He has also recognized that a pollen—a stranger to a plant—being unable to cause the growth of an embryo in its ovules, may, nevertheless, produce an excitement which determines the production of a fruit normal in appearance, but without seeds, or with only infertile seeds."

ADMIRAL FITZROY ON THE WEATHER.*

Few men have done so much practical good with so little pretence as Rear-Admiral Fitzroy, whose forecasts of the weather are looked for with eagerness all round our shores. The science of Meteorology being in a very imperfect state, and atmospheric conditions depending upon a great variety of circumstances exerting a highly complicated action, absolute *prediction* is not possible, and is distinctly repudiated by the scientific sailor, to whom his own profession and the public owe so much in the way of serviceable warning and useful instruc-

* *The Weather Book.* A Manual of Practical Meteorology, by Rear-Admiral Fitzroy. Longman and Co.

tion. In France the Admiral's labours are highly appreciated, and we apprehend the government of that country will find itself obliged to follow the excellent example of our own in the establishment of a "Meteorologic Office," by which the probabilities of coming weather may be made known. A recent number of *Cosmos*, commenting upon our system of weather-signals, observes that "the warnings given by Admiral Fitzroy have saved many vessels from certain disaster, but human cupidity has often neglected his indications." This is no doubt true, but we cannot wonder that success should be slower than benevolent desire, as the world is partially governed by conservative instincts, and those who introduce beneficent novelties must move a huge load of rubbish, in the shape of ignorance, prejudice, and obstinacy, before the ground is clear on which they can operate with effect. The unintelligent man desires to repeat to-day what he did yesterday, without the labour of progress, or the trouble of research. The intelligent man takes a nobler view of nature and her possibilities, life and its duties. He feels that to-day should avoid the errors of yesterday, do something to make up its short-comings, and lay the foundation of completer action for the day that is to succeed. Among the unintelligent class, Admiral Fitzroy may have met with the treatment they habitually accord to benefactors who disturb the equanimity of indolence, or torment the laziness of repose; but the scientific contemporary we have quoted speaks truly when it says, "The science, of which this distinguished man, in spite of sarcasm, is the apostle, is in its infancy. No one is more ready than he to admit this. It may at times deceive us—of this there is no doubt, but we may hope the time will come when it will speak with perfect surety. Even now, when Admiral Fitzroy hoists his alarm signals at the ports, a storm is probable, and prudence commands small vessels or weak ones not to tempt the danger of the seas."

It may also be observed that all the existing means of intimating probable weather changes are not yet at the disposal of the Meteorologic Office, and those who have read our notices of the investigations of Father Secchi at Rome, will be prepared to believe that the variations of force and direction in the magnetism of the earth afford indications which are not to be despised.

Admiral Fitzroy has effectively contributed to what we may call the science of weather observation. He collects information from a number of places, chosen with reference to their meteorological position, and this information he interprets according to a theory, which is probably correct as far as it goes, and then publishes, through the newspapers and by signals, the *forecasts* at which he arrives. Occasionally a storm

may come not included in his programme, or his danger drum may be hoisted for a tempest that does not appear at the appointed time and place. It would no doubt be more satisfactory if greater certainty could be introduced, and that we may expect at a future date; but it is a grand thing to have got so far, as to exhibit all round our coasts distinct intimations of *tendencies* which are likely to take effect, and thus to establish a probability, according to which a vast number of actions may be regulated with the certainty that, *on the average*, the anticipated result will be obtained. The principle upon which the Admiral works can only be understood by a brief sketch of the causes of atmospheric perturbations, and to them we must devote a few explanatory lines.

The earth's atmosphere is divisible into two portions, lower and upper—the *stable* and the *instable*. It is not meant that absolutely no motion or change takes place in the upper division, but all the phenomenon of winds and storms occur in the lower one, as explained in a former number.* Opinions differ as to the total height to which the atmosphere extends. Admiral Fitzroy supposes that "as air, from ten to twenty miles seems a probable total depth," while about seven miles seems to be the limit in which man can exist. We do not perceive precisely what the Admiral means by the phrase "as air," but he may agree with the opinion of Quetelet, that the composition of the atmosphere may not be the same at great elevations, where the pressure becomes infinitesimal. However this may be, we do not coincide with his view that the total height is less than is usually supposed, but prefer the opposite supposition of the distinguished Belgian philosopher. Still, so far as relates to weather prognostications, our researches must be chiefly devoted to what takes place within a few thousand yards of the earth's surface; and if the loftier regions—in which miles of elastic matter in the gaseous form contribute next to nothing to the total weight of the atmosphere, as shown by the barometric tube—should ultimately be found to exert a noticeable influence upon the perturbations of the lower layers, it will probably be on account of the magnetic disturbances of which Quetelet conceives them to be the scene. The instable portion of the atmosphere is much lower in winter than in summer; but even when its volume, and consequent height, is enlarged by the action of solar heat, it cannot reach much above the highest mountain top. The chief cause of air currents or winds is undoubtedly the action of the sun; but the earth's rotation must not be disregarded, as it is very important, and the moon probably exerts a tidal influence upon the air as well as upon the water of our globe.

* Quetelet, on "Shooting Stars," No. 13 (vol. iii.), p. 34.

If no disturbing operations took place, we should only have hot air rising from equatorial regions, and being replaced by colder streams from the less heated poles. The real facts are, however, in the highest degree complicated, as many distinct forces contribute more or less to excite motion at different heights and in different directions, and a host of circumstances, such as the distribution of land and water, mountain ranges, plains, etc., etc., produce modifications over a wider or smaller range.

Notwithstanding the mobility of air, the commingling of currents of different densities does not take place as quickly as might be supposed, and we are all well aware of the obstinacy with which ordinarily-constructed rooms resist a complete ventilation, and of the amazing change felt by placing ourselves just inside or just outside the lintel of an open drawing-room door, at one of those afflicting ceremonies called an evening party, where the guests largely outnumber the chairs, and demonstrate how little oxygen is necessary for the mere sustenance of human life. These facts must be borne in mind, or the co-existence of adjacent currents of different densities, each pursuing an independent course for hundreds of miles, will not be understood. Liquids mix with similar slowness, as may be seen if a glass of cold red wine is slowly poured into a tumbler of hot water, and no spoon permitted to accelerate the union of the two. Should the reader think this illustration more domestic than poetical, or object to it upon teetotal grounds, we may remind him of the story of Arethusa, so exquisitely told by Shelley. The startled nymph rushed to the sea to escape the violence of Alpheus, and as she took her flight through the waters,

> "Behind her descended,
> Her billows unblended
> With the brackish Dorian stream."

The ocean exhibits similar phenomena for thousands of miles. Admiral Fitzroy tells us that, "taking, with Dové, north-east and south-west (true) as the wind poles, all intermediate directions are found to be more or less assimilated to the characteristics of those extremes, ... and all *varieties* of winds may be clearly and distinctly traced to operations of the two constant principal currents, polar and tropical—*our* north-east and south-west winds." Polar currents are cold, dry, and positively electrical. Tropical currents warm, moist, and negative. Mixed currents have necessarily intermediate qualities, and continued collisions and conflicts occur between currents of all kinds. The state of affairs on our own coasts is well shown in the following passage from the Admiral's book:—"A stream of polar wind traverses the North Atlantic over Ireland and Scotland. As it

advances southward, it also moves (or is carried with the whole atmosphere) eastward, so that its effect is first felt in Ireland and Scotland. Advancing southward still, before approaching Norway, it is impeded by Scotch highlands (4000 feet), and then affected by Norwegian mountains (8000 feet). The increasing current of air (or *wind*), advancing, widening, and augmenting in momentum, passes round Scotland, between it and Ireland, along the Scottish eastern shores, and urged from behind, while in front checked and deflected by Danish, Dutch, and French coasts, this *polar* wind becomes more or less *easterly* on our coasts. There is no *true* east wind in our zone that has come from any *considerable distance due east*, moving towards the west. Polar winds deflected by local configuration and the earth's rotation become more or less easterly. When a tropical current is advancing, its extremes intermingle with the yielding or diminishing opposites (the polar), deflect them, and (affected also by local configuration of land) become south-easterly before they turn to southerly, and then to south-west." This is the usual order, but retrograde movements may take place, giving rise to squalls. A low barometer, with moisture in the air, as shown by Mason's hygrometer or other instrument, and a warm temperature, are the effects of the tropical current. On the other hand, a high barometer, diminished moisture, and falling temperature are the effects of the polar current. At times, however, the disturbing influences prevail over the normal, and during the last winter south-west winds have occasionally brought frost, while the temperature has risen during the period in which the air currents have been from the north.

These considerations will enable the reader to appreciate the system of weather *forecasts* introduced by Admiral Fitzroy, which is founded upon the indications of ordinary instruments, barometers, hygrometers, and thermometers, and upon the ordinary march of atmospheric currents, by which a particular state of weather in one place affords grounds for supposing what will be its state in other places situated so as to receive a similar, though perhaps modified, influence at a later date.

Upon the difficult question of the action of the moon, Admiral Fitzroy has an interesting chapter, and he does not consider that the probability of an important tidal influence is invalidated by the fact that the barometer does not give proportionate indications. He believes that there is "a continuous overflow of air, like that described by Dové and others, which not only prevents much sensible increase of statical pressure or tension, but augments the dynamical forces of the tropical currents of air, periodically by lunar periods, and diurnally also." This theory is probable, and the Admiral states that "recurring

periods of about fourteen days (semi-lunar), of seven, and of three or four days, have been traced, however masked or irregular, more or less synchronous with the moon's phases, *occasionally*, and then for a few times rather correspondent, therefore evidencing some kind of connection." The Admiral also observes that the consecutive actions of the moon in raising and causing an overflow of a mass of air must give rise to periodical impulses bearing a different direction to the normal currents.

"During the moon's passage from quadrature to syzygy her action on air currents should increase, and conversely, when she has great north declination, it ought to be greater here than when she is far south, and when in perigee greater than in apogee. Tabular records show such are the facts." Abstract reasoning tends to the conclusion that the moon must influence our atmosphere, although forces more powerful than that exerted by our satellite may counteract or conceal her work, but, as we shall see, distinguished authorities adopt conflicting views.

Admiral Fitzroy appears to connect the successive impulses to atmospheric movement given by the moon with the daily changes that occur at intervals of about six hours. Lunar actions may have something to do with these, but they seem more directly referable to the operation of solar heat and of radiation. Quetelet says, "If we compare the variations of the barometer with that of the thermometer, we observe that oscillations of pressure as well as of temperature are much stronger in winter than in summer;" but he adds that in autumn there is less difference in the barometer and thermometer than might have been anticipated. He likewise observes that the diurnal variations of the barometer, which take place at intervals of about six hours, exhibit peculiar displacements, so that in winter the interval between the maximum and minimum of pressure diminishes a little, and augments in summer.*

Professor Lamont believes that the sun exerts two influences upon the diurnal variation of the barometer, one that of heat, and the other of an "electrical" attractive force; and Professor Plantamour considers that the tidal action of the moon on the air is shown to be insensible, by observations which he carried on through twenty-four lunations. He says,† "I have taken the mean barometric heights, observed at different hours, the day of the syzygy, the day before, and the day after; the day of the quadrature, the day before, and the day after." He then gives the result of 144 days at the syzygy epoch, and of 144 days at the quadrature epoch, which do not correspond with what might be computed from the lunar-tidal theory. He also gives the hours at which the maxima and minima occurred

* *Physique du Globe*, p. 13. † *Archives des Sciences*, No. 61, p. 72.

at syzygies and at quadratures, and remarks, "the second terms (minima) are nearly identical in value, and the time only differs a few minutes; while if the atmospheric tide came from molecular attraction, exerted by the moon as well as by the sun, the time of minimum at the quadratures ought to have changed by six hours, and its value should have been reduced about one-third."

We do not presume to decide this very difficult question, and regret that the length to which our remarks have already extended precludes the notice of many important points in the *Weather Book*, a work which will interest and instruct many readers who would be alarmed at the sight of a more formal treatise, and which is illustrated by numerous valuable diagrams, to which the student will be glad to refer. The present edition is a handsome one, and necessarily expensive; but looking to the popular interest of the questions discussed, and the good that would result from placing the Fitzroy philosophy within the reach of seafaring men and agriculturists, we hope the respected firm of Longmans, to which the copyright belongs, will be able to accommodate itself to modern ideas and publish a cheap *Weather Book* without delay.

NIEPCE DE ST. VICTOR ON HELIOCHROMY.

In the Intellectual Observer, Vol. I., page 163, will be found some account of the reproduction of colours by the photographic process of M. Niepce de St. Victor, who has recently brought the subject again before the French Academy, in a paper from which extracts are given in the *Comptes Rendus*,* whence our present information is derived.

After observing that the reproduction of colours in the dark chamber affords the best exhibition of the powers of heliochromy, which, although not competent to obtain all results, has yet achieved an important success, the writer explains that he has now surmounted the difficulty of obtaining yellow tints. At first, he reproduced red, green, and blue with facilty; but if yellow appeared, it was accidental; but he now developes it with certainty, by acting upon the silver plates with hypochlorite of soda in preference to potash. He finds chloride of tin, aldehyde, and tincture of benzoin, especially that of Siam, contribute to fix the colours; and he observes that, if we hold a heliochromic picture at a certain degree of incidence, the colours appear more vivid and the shadows more intense. He

* January 12th, 1863.

adds, that when the model—a doll—is illuminated by solar rays, the colours obtained in the dark chamber are much modified and more brilliancy obtained.

The binary or secondary colours of the artist are decomposed by heliochromy; and M. Niepce de St. Victor remarks that if M. Edmund Becquerel has really obtained a complete solar spectrum by this method, such a result would indicate that the spectrum colours are simple, and not composed, as Sir David Brewster conceives, by the superposition of three monochromatic spectra—red, yellow, and blue. To illustrate the effect of light on a mixed colour, M. Niepce contrasts the result obtained with different kinds of green. The green of an emerald, of arsenite of copper, oxide of chromium, sulphate of nickel, or malachite, is reproduced by heliochromy; but green composed of blue and yellow pigments give a blue result. This suggests the notion that there is an essential difference between simple and compound greens, although they may appear the same to the eye. If a clear blue glass is placed over a clear yellow one, they transmit a green light; but the action upon a heliochromic plate is that of blue only, even when the blue glass is placed between two yellow ones. In like manner, a yellow glass and a red one, producing orange by transmitted light, only yield a red on the sensitive plate. Red and blue glasses at first afford a violet tint, because the sensitive plate is itself red, but after a little time the effect is blue. If an orange glass replaces the red one, the blue tint appears the more quickly. The green of grass is reproduced by a blueish grey; blue greens, like dahlia leaves, yield a more decided blue; and yellow or red leaves are reproduced with fidelity in proportion as the blue tints are absent, which M. Fremy has shown constitute, with yellow, the green of plants. The eye of the peacock's feather can be imitated well, so that the colours appear green or blue, according to the angle at which it is seen.

PRIZES OF THE FRENCH ACADEMY.

In the mathematical section of the *Academie des Sciences* no prize was adjudicated for papers on the question of Tides at the principal ports of France, and the subject was remitted for competition in 1865. Two thousand francs and a medal of half that value were adjudged to the author of papers on the "Theory of Plane Curves of the fourth order." The "extraordinary prize" of 6000 francs for an essay on the "Application of Steam to Naval Warfare" stands over. The chief astronomical prize (Lalande's Foundation) was given to Mr. Alvan Clark for his discovery of the companion of Sirius with an achromatic telescope of his own making, $18\frac{1}{2}$ inches in diameter and 23 feet long, and thus exceeding by $3\frac{1}{2}$ inches the aperture of the grand instruments at Pulkowa and Cambridge, U. S. The Montyon statistical prize was given to M. Mantellier for a memoir on the "Value of Provisions and Merchandize in Orleans, from the fourteenth to the eighteenth centuries inclusive." Among other curious matters it appears that in 1439 the city of Orleans bestowed a pension of two livres Tournois per month, estimated at 23 francs 91 cents present money, on the mother of Joan of Arc. The average price of corn at that period was, however, so much lower than at present, as to make the corn value of the pension equal to 827 francs a year. An honourable mention was given to M. Champion for a work in four vols. 4to on "Inundations in France, from the sixth century to the present time." From the statistics collected by the author, the Commission report that "the magnitude of inundations appears to have been the same in all historical periods—at the epoch when ancient forests covered the soil, and at times when the removal of the wood has been a subject of complaint." The Bordin prize was adjudged to M. Carl Miersch, of Dresden, for a paper on the "Causes which Influence the different Positions of the Optical and Chemical Foci in Photographic Lenses."

No prize was given for papers on the "Comparative Anatomy of the Nervous System of Fishes;" but an essay by M. M. Philippeaux and Vulpian possessed so much merit as to be rewarded by 1500 francs. The very curious question of Vegetable Hybrids having been carefully investigated by M. Naudin, a prize was adjudged to him, and honourable mention made of another paper by M. Godron. M. Naudin finds experimentally that the fecundity of hybrids is in general proportioned to the resemblance in external characters of the species which produce them, but not always. For example, plants belonging to Datura, Nicotiana, and Cucumis furnish instances of species closely allied in external appearance, which commingle with difficulty or yield only sterile hybrids, while other species of greater botanical diversity readily produce hybrids of great fertility. Other points of interest appear, to which we have reverted in another place. The important researches of M. Balbiani on the "Reproduction of Infusoria," which we have already laid before our readers, were very properly rewarded by a prize, and another was given to M. M. Chauveau and Marey for "Studies on Cardiac Circulation,"

noticed in our first vol., p. 84. M. M. Cruveilhier, Lebert, and Frerichs received prizes for Anatomical and Medical works. M. Pasteur received the Alhumbert prize for 1862, for his experiments on "Spontaneous Generation," which have been fully explained in our pages; and M. de Bary received honourable mention for "Researches on the Development of Parasitic Fungi;" and that for 1861, the subject being "On the Modifications which can be Produced in Development of a Vertebrate Animal by External Agencies," was divided between M. Dareste and M. Lereboullet for elaborate experiments on fowls' eggs.

The Medical and Surgical Commission reported that no work laid before them on the Treatment of Cholera, or the Causes of Fevers, merited a prize; but they proposed a pecuniary award to M. Barralier for a paper on the "Non-Identity of Typhus and Typhoid Fevers." In 1837 a paper supposed to establish their identity was greeted with a prize.

MINSTRELS OF THE SPRING.

BY SHIRLEY HIBBERD.

How would a blind man know, without human aid, of the changes of the seasons? In this country, and in such a season as the present, he would gain no hint from the prevalence of storms, the chills of winter, or the warmth of spring. On Christmas day we had May temperature and sunshine; and during February it has been so warm that roses have opened their blooms in the neighbourhood of London. But the blind man, whether a Homer or an Œdipus, a Huber or a Belisarius, if ever an observer of nature in the days of his proper vision, would be able to count off the months, and sometimes the weeks, by the voices of the birds. True to the almanacs, within a few days, from far to near, and in some cases true almost to an hour, the songsters of the woods and gardens publish their arrival, and their changes of mood, and feeling, and prosperity, in their calls, carols, and utterances of fear, warning, anger, love. There is always a dead pause from the middle of August till the middle of October, when the sparrows and chaffinches have it almost to themselves, to do as they please with the hedgerow and woodside echoes. Then the concert begins again, with the robin as leader, and a succession of performers follow, fieldfares, redwings, missel-thrushes, song-thrushes, blackbirds, wrens, and finches of many kinds. But all these make little more than a confused twittering, amidst which rises, distinct and clear, the rich but melancholy warble of the robin, and the loud detached whistlings of blackbirds and thrushes. Yet though our winter music

is poor compared with the season when spring and summer mingle among the darkening greenery, we are much better off than is commonly supposed. October brings us the migratory *Merulidæ*, the fieldfare (*Turdus pilaris*, Will.), the redwing (*T. Iliacus*); and the missel-thrush (*T. viscivorus*), which never leaves us, appears as a migratory bird amongst the gardens, where it is seldom seen at other periods of the year. With these we may group the crossbill (*Loxia curvirostra*), with its musical "tutter tutter," the siskin (*Fringilla spinus*), with its incessant small song, so like, in some of its odd passages, the sound of the loom, that it is the greatest favourite as a pet among the weavers of Nottingham and elsewhere. The mealy redpole (*Linota canescens*) visits us only in hard winters, and has this season been a scarce bird, and when plentiful its song is but a poor affair; but it has a musical companion in the mountain linnet (*Linota montana*), which sings nearly as well as the common linnet. As for the finches they literally smother the gardens occasionally, then break up and appear singly, and make a plentiful twittering when food is abundant. There is the common wren (*Anorthura troglodytes*, Niac.), the gold-crested wren (*Regulus auricapillus*, Selby), and the fire-crested wren (*R. ignicapillus*, Mudie), always with us, flitting from bush to bush, rarely mounting among the branches of high trees, and all of them so easily approachable that it would be possible to train quick-sighted, nimble boys to take them by the hand. The pied wagtail (*Motacilla alba*), and the greenfinch (*Fringilla chloris*, Temm.) give their occasional touches of music, the first about the margin of the pond, and the second among the orchard trees, where it performs its harsh "chink" with a pertinacity worthy of a softer throat.

These are not all the true winter songsters, but of the rest we can scarcely take note, for they are either rare and local in occurrence, or contribute so little to the concert as to be scarcely worthy of notice. But the opening of the first crocus is the signal for a general outburst. Then the loud blackbird, with his restricted compass and unskilful execution, makes amends for poverty of art by lustiness of expression, and leads the way, as the robin did before, but to a nobler chorus. From every copse and hedgerow now resounds the full melody of the garden thrush, a perfect song, monotonous, yet so full and joyous that we rarely pause to criticise; and above it rises the ousel's clarion, shrill and decisive, pronouncing that the time of singing birds is come; and the copses are being newly drest with spanglings of gold and silver. All the winter long I have heard the skylark trilling out his cheerfullest of melodies in the sunny sky over our suburban meadows; and now the sky is on bright days almost dotted with these spiral-flighted

songsters, the freest and wildest of all the birds of spring. I like to note at this season how far our poets and painters have hit or missed the mark in their renderings of nature. That oft-quoted song from Shakspeare's "Midsummer Night's Dream"—

> "The oosel-cock, so black of hue,
> With orange tawny bill;
> The throstle with his note so true,
> The wren with little quill,—*Act* 3, *s.* 1,

is next akin to a zoological monograph. "So *black* of hue" is no haphazard expression; the "oosel" is the blackest of all birds, blacker some degrees than the raven; and the "orange-tawny bill" is such a perfect complement of colours that it is unquestionably the most artistically painted of all the British aves. Contrast Shakspeare with Pliny, who tells of blackbirds becoming red in winter, and see how the quaint writer and careless observer confounded the sexes, and made the brown female a transformed and dilapidated gallant. Pliny does not tell of the most curious of all the facts in the history of the blackbird, that it is the most subject to albinism of all the birds of Europe, and a genuine *white* ousel is by no means a rare sight. I remember seeing one when a lad; it was shown for sixpence, along with a three-legged colt, in a stable-yard in the Blackfriars Road. There is a cream-coloured specimen in the British Museum, and some years ago there was one in the Zoological Gardens with a black body and a white head. The sparrow is also much subject to albinism, but in a less degree than the blackbird; I saw two white sparrows in the collection of Dr. Hobson, of Leeds, some few years ago.

But is the "oosel-cock" of Shakspeare the same as our quarrelsome and loud-spoken blackbird? some have denied the identity, for no good reason that was ever alleged. Drayton studied nature in the same fields as the great poet, and at the same time, and he classes together two birds that have inevitable companionship—

> "The *throstel*, with shrill sharps, as purposely he song
> T'wake the lustless sun, or chiding that so long
> He was in coming forth, that should the thickets thrill:
> The woosel, near at hand, that hath a golden bill."
>
> *Poly-Olbion*, 13.

Not to pass from Shakspeare too hurriedly, for *he* is the chief of our spring minstrels, who stood between the winter song of Chaucer and the summer-time of literature, when Milton made our language marvellously vocal; observe the next line—

> "The throstle, with his note *so true*."

When the Hon. Daines Barrington classified the chief singing

birds as to their comparative excellences, he assigned to the thrush four points of perfection (twenty being the maximum) in all the qualities of mellowness, sprightliness, plaintiveness, compass and execution; and there is but one other bird in that table classed with equal numbers all through, and that is the titlark, a charming songster, which has twelve points in each section. The song of the throstle is essentially true. When you hear now a huge whistle, followed by a discordant jar—that is the ousel; when next you hear a mellow, lively, plaintive song, lusty and loud—that is the throstle, the nightingale of spring. It did not escape the quick perception of Shakspeare that loud and lively music in a regular measure prompts the hearer to dance or sing to the same tune, and in the "Merchant of Venice" Portia describes the susceptible sensitiveness of Monsieur Le Bon: "If a throstle sing, he falls straight a capering"—a passage which might any day form a text for an essay on analogies and sympathies. What now shall we say of the last line of the song, "the wren with little quill?" Let us suppose—a fair supposition in regard to a lad who put a longing eye upon the deer in Lucy's Park—that Shakspeare was in his youth given to the practice of the gentle craft beside the leafy Avon; then he would have prized, as modern anglers do, the tail feathers of the wren as the best of all baits for trout, and the remembrance of the fact would suggest the "little quill" as he grouped together the three liveliest and truest birds of winter and early spring. If any angling reader of this has found excuse for using the gun to obtain wren's tails, we counsel him to adopt the more merciful plan recommended by Mr. Broderip: Set a lad to catch wrens by hand—an easy thing to do—and, having plucked a few of the tail feathers, let the bird go free; he will soon repair the loss, and be none the worse for the robbery.

Modern poets freely use the license allowed them, and many are the violations of truth observable in works which rank among our classics. I have several times during the past winter watched the groups of fieldfares which haunt the quieter parts of our meadows and arable lands, and have compared Scott with Gisborne, to note which had painted nature in the truest colours. The fieldfare arrives early in October, and leaves us some time in April, and never stays beyond the second week in May. Yet Scott in the "Lady of the Lake" describes it as a summer bird—

> "Beneath the broad and ample bone,
> That buckled heart to fear unknown,
> A feeble and a timorous guest,
> The fieldfare framed her lowly nest."

Gisborne indulges in the extreme of accuracy, reminding

one of the "inventory style" of Crabbe, yet his picture is charmingly truthful—

> "Lo! on yon branch, whose naked spray o'ertops
> The oak's still clustering shade, the fieldfares sit,
> Torpid and motionless, yet peering round,
> Suspicious of deceit." *Walks in a Forest: Winter.*

Among our Stoke Newington birds the principal at this season are the commoner species of *Merulidæ*, the common wren, the skylark, woodlark, robin, and hedge-sparrow. As for the wrens, they flit about in the hedgerows like mice, and utter their cheerful miniature song with as much boldness as the bravest of our songsters. Now among the special indications of spring must be noted the occasional appearance of *hen* robins, and everywhere among the songsters pairing time is anticipated through the unusual mildness of the season. Thus we have a commixture of warblings, and at midday, when the blackbirds and thrushes sing with less vigour than at dawn and dusk, the robins and the hedge-sparrows have the welkin almost to themselves. Already the robins have paired, and commenced their household work, perhaps to be undone by eastern blasts when the fruit-trees are all in blossom. But whoever would now combine literary with ornithological musings may make a scientific study of the "Babes in the Wood."

There have been but few experiences gained as yet in the use of synthesis in natural history. It is all analysis at present, but in the future of the physical sciences we must hope to see synthetical methods of reasoning turned to as good account in this science as in chemistry, astronomy, and geology. When I look around me at a number of pet birds in cages, I cannot resist the temptation to work out general conclusions as to the history of species from the material furnished for the purpose by individuals in a state of confinement. Our common observations about the changes that occur in the habits of animals when brought directly under the influence of man are, after all, very vague and unsatisfactory. I find, as do other folks who keep pet birds, that in a state of confinement the season of song is, in the majority of cases, greatly prolonged; and if it be asked, "Why is this?" the reply is obvious: that shelter, warmth, and abundance of food favour a joyful state, and this the bird expresses in its own way, and so repays us for our attention. We are just emerging out of winter into spring, and the winter has been unusually mild, and many birds whose voices are hushed during the season of frost and snow have been continuously vocal; and the plentifulness of bird music confirms me in the opinion that the comforts of life have very much to do with frequent expressions of joyousness. So,

passing from generals to particulars, if we note the kind of food which any particular bird prefers and thrives upon, we have somewhat of a key to its habits and history when in a state of nature. The birds we feed on soft food soonest suffer during hard frost, and so severe winters kill off blackbirds, and thrushes, and larks, and perhaps robins; for then their sustenance ceases to be available, even if plentiful, and is more likely to be scarce in quantity, and therefore doubly unavailable. The sentiment which prefers the free, wild song of the uncaged bird is wholesome and to be encouraged, but it is a question if the history of any bird can be truthfully written without the aid of such opportunities for observation as are afforded by the cage and the aviary. Audubon tells of parrots scratching each other's heads when congregating on the branches of their native trees. I believe the statement, because, when I allow a couple of parrots to exchange familiarities, the first thing they invariably do is to engage in mutual scratching, and with extraordinary earnestness. I had some doubts about the size, and shape, and colour of the eggs of the small white cockatoo *Psittacus sulphureus*), until a bird of mine (strangely called in our household language "the boy") presented me with a couple of eggs—pure white, and the size and shape of plover's eggs. When I reflect upon the mysteries of migration, I am strongly tempted to sweep away all the fanciful theories of "mysterious instinct," and reduce the phenomenon to a question of food and temperature; and the conclusions in this direction which caged birds have suggested I find pretty well exemplified in observations of natural events, and remarkably so in the experiences of this winter. Let us endeavour to illustrate the case by a few remarks on the minstrels of the winter.

The *Sylviadæ*, or "warblers," which visit us in spring and depart in autumn, have their counterparts in the *Merulidæ*, or thrush tribe, which visit us in autumn and depart in spring. True, many of the noblest of the *Merulidæ* are permanent residents, and a few are only partially migratory. One of the most regular of the winter visitants is the fieldfare thrush (*Turdus pilaris*, Will.). It comes in October, and appears in various districts at different dates, as the individuals spread themselves over the country. At Stoke Newington it is a *rara avis*, yet I generally see a few in the early part of November, and thence to the end of March. Very often on mild damp days flocks of fieldfares and redwings (*T. Iliacus*, Will.) traverse the flat meadows together, generally in the wake of feeding crows. In a season like the present these birds are fat and occasionally vocal, their food consisting wholly of insects and molluscs, which they find in greater plenty in the track of the crows than elsewhere, those expert foragers serving as jackalls to indicate

the locality of prey. But in a hard winter the fieldfares and redwings soon get thin; snails and slugs and insects are scarce, and they betake themselves to the berries of holly, berberry, ivy, mountain-ash, and hawthorn; and however plentiful these are the birds barely secure a subsistence from them, and, while trusting to such food, are invariably silent. When the Romans fed these birds for the table their food consisted of figs and flour; they might have fed with berries to any extent and with any variety, and the result would have been complete failure. Now, let any possessor of caged *Merulidæ* test the dietary of these birds by giving them abundance to choose from, and what berry will they touch while good "paste" is obtainable, and is there one that will prefer a haw or sloe to a fat slug or wriggling worm? Not one. But give them snails in plenty, and you shall be rewarded with a concert.

Our winter concerts would, however, be very poor were we dependent only on wandering minstrels. The resident songsters keep the echoes of the hedgerows awake, and what a variety of these we have that brave our winters, and give us Christmas carols and new-year songs. Since the beginning of December scarce a day has passed that I have not heard the notes of the blackbird (*T. merula*); but in a hard winter he, too, would be mute till the eastern sky showed again some of those saffron bars that indicate the dawn of spring. So the song thrush (*T. hortensis*) has been singing joyously all the winter long, though not in the best tone, and the missel-thrush (*T. viscivorus*) has nearly equalled it very often, and has been unusually plentiful here of late. Now the balance of song is very nicely established between summer and winter. The summer song of the nightingale has a counterpart in the winter and spring song of the garden thrush, a more powerful songster, though so deficient in compass, mellowness, and execution; and in place of the whole tribe of warblers, with the blackcap at their head, we have in winter a number of lively finches and larks, with the robin for captain; and so the months are attended by the several minstrels of the seasons. With every advance of the season the song thrush increases in volume of voice, and in volubility of expression. There is such a joyous outpouring of song that the few notes over which the song ranges, and its poverty as a composition, are unnoticed while we yield to the spirit of gladness which pervades every utterance, and accept quantity for quality, and esteem ourselves happy that the season of awakening has so suitable a voice. But as the garden thrush rises to the full swell of his jubilant melody, the missel-thrush declines in power, and actually improves in sweetness, though it is certainly one of the least musical though the largest and handsomest of the thrushes. To hear the discordant scream this bird will utter

when the wintry storm has just begun to lash the pane, and cause the trees to creak and moan, is to acquire somewhat of a horror of the species. The way in which the songs of birds affect us could best be told by a master of thorough bass, and one of the essentials to the pleasurable study of ornithology is a knowledge of the laws of musical harmonies. The thrush is in reality a poor performer, but he sings in the chromatic scale, and every note tells with full power on the feelings. The song of the robin is remarkable for its compass and sweetness. Barrington assigns to it six points of mellowness, sixteen of sprightliness, twelve of plaintiveness, twelve compass, and twelve execution. Yet with all these excellences it does not affect us so strongly as the poorer performance of the thrush, and the reason is not hard to discover, for the robin sings in the minor key. But we must guard against being led into error in endeavours to analyse bird music according to the laws of harmony. There is no regularity of pitch, no correct concord of measure and rhythm, and often the odd disregard of the bird for principles which the musician considers of the first importance, affords us a pleasure to which there is no parallel among the attainments of the human performer. Here it is that Pope's line has a special application, the song bird knows how to—

"Snatch a grace beyond the reach of art."

NEW DECIMAL COINAGE FOR HONG-KONG.

BY JOSEPH NEWTON, OF H. M. MINT.

It is satisfactory to be able to announce that it is the intention of the British Government to cause a new and distinctive coinage to be struck for the young, but flourishing and populous, colony of Hong-Kong. The metallic currency of that place has hitherto consisted of as strange and heterogeneous a collection of coins as could possibly be imagined, and the confusion and mystification arising from this state of things are intolerable in the highest degree. Spanish and Mexican dollars are intermingled with small and large pieces of money from almost every part of the world, whilst the miserable specimens of Chinese mintage, known as "cash," which largely circulate among the native population, serve to make the jumble complete. It is in consequence of strong representations from the colonial authorities, and merchants of Hong-Kong, as to the evils and annoyances arising from this serious defect in the currency, that the home government has determined to remodel it.

Much care and caution will have to be exercised, no doubt, in the introduction of a new coinage, because a very large proportion of the inhabitants consists of Chinese, and their peculiar habits and prejudices must, to a certain extent, be respected. It will not be possible to wean the "Celestials" all at once from their ancient notions of monetary matters, or to familiarize them easily with our own views of the very terrestrial subject of pounds, shillings, and pence. The transition must, indeed, be made gradually, and, if possible, without shock to the feelings of John Chinaman. We believe that the Duke of Newcastle, in his official capacity of Secretary of State for the Colonies, has fully considered the difficulties which will have to be surmounted in effecting the proposed change, and the plan of operations agreed upon between him and the talented governor of Hong-Kong, Sir Hercules Robinson, seems to be well calculated for overcoming all the practical and moral obstacles in its way.

It is intended that the dollar shall, for the present at all events, remain as the unit of value, and that the new series of coins shall comprise decimal divisions of that unit. The

NEW COINS FOR HONG-KONG.

subsidiary coins will be named respectively, ten cent pieces, which will be of silver; one cent pieces, of bronze; and, for the purpose of humouring the Chinese, British "cash" pieces or mils, also of bronze. The first-named coin will be equal in value to the ten cent of Canada, or the tenth part of the dollar; the second, to the American cent; and the third, or British cash, will represent the one-thousandth part of a dollar. It may appear somewhat singular that coins of so small a value as this last—less considerably than the fourth of a farthing—should be deemed necessary; but the innumerable variety of articles

which, in the markets, shops, and street-stalls of Hong-Kong are fixed at the price of a single cash is at once a justification of the proceeding, and a proof of its necessity. The last census of the colony demonstrated the fact that there were 120,000 Chinese residents in it; and as these have from their childhood been accustomed to the use of the "cash," it has been thought advisable to supersede the rough native coin of that name by a well-finished and handsome specimen of English mintage, presenting some of the characteristics of the Celestial piece. It is, perhaps, scarcely essential to inform our readers that the "cash" of the Chinese empire is simply a thin disc of gun-metal, ornamented by hieroglyphics—if the term be admissible—and which has been cast in a mould, not struck from dies. It has, moreover, a square hole in its centre. The diameter and weight of the cash have varied considerably under different emperors, as have the Chinese characters supposed to ornament it. These inequalities have not tended to lessen the annoyances arising from the mixture of coins circulating in Hong-Kong. In the proposed new coinage of "cash," or mils, there will be, of course, uniformity of weight, size, and inscription. The hole through the centre of the piece will be retained. This may be regarded as a Celestial institution in fact, for all good Chinamen prefer stringing their money, like beads, round their necks, to carrying it, as we outer barbarians do, in our pockets. The hole will, as shown in our illustration, be a round one, of about three-sixteenths of an inch in diameter; and whether this arrangement will square with the ideas of our pig-tailed fellow-subjects, remains to be discovered. It certainly prevents the coins bearing the image of our beloved queen—a matter for regret—although its being a round, instead of a square hole, facilitates, mechanically speaking, the process of coining them.

The devices which ornament the "mil," it will be seen, are simple, and as appropriate as the perforation through its centre would allow. The Chinese characters forming the reverse of the coin are to the same purport as the superscription on the obverse. The first instalment of British "cash" transmitted to the colony will equal, it is believed, not less than twenty millions of pieces. The contract for striking these has been taken by the Messrs. Heaton, of Birmingham, but, of course, the work will be carried on under the direct supervision of officers of the Royal Mint. The smallest of the series of coins has been spoken of first, because really it is that which will probably become the most popular in the colony, and by far the largest number of pieces sent there will be of this denomination. There may be a little room for doubt as to whether the relative smallness of the British, as compared with the Native, cash, may not create some dissatisfaction in the Celestial mind;

but, as a rule, the Chinese are acute, and once they find that their new necklaces, although much lighter in weight, represent as much, or more, value than their old ones, they will be soon reconciled to the change.

There were persons nearer home who objected in the first instance to the introduction of the now popular bronze coinage, because of the comparative smallness of the coins composing it. They, however, have outlived their objections; and so will the native inhabitants of Hong-Kong, if they happen to have any, to the more portable cash or mil.

Of the ten cent piece an illustration is shown on another page, and it will be acknowledged that the designs of both obverse and reverse are excellent, as they are in the originals well engraven. There is a boldness and elaboration of workmanship about the profile of Her Majesty which cannot but command approval. The piece is well-proportioned too, an important point in all coins. One hundred thousand ten cent pieces will be coined in the first instance at the Mint, but these will be followed, in all likelihood, by several hundred thousands more.

A million of one cent pieces are to be struck immediately, and as our artist has done justice to the devices which are to ornament them it is not requisite to say more on that subject. The same remarks, indeed, which have been used in regard to the ten cent silver coin will apply with even greater force to the one cent bronze piece. It is only just to state that to Mr. T. J. Minton, Acting Engraver to the Royal Mint, is due the merit of engraving the reverse dies for the whole of the series of Hong-Kong coins, and of the obverse die of the ten cent piece. The obverse die of the one cent is identical with that engraved by the late Mr. William Wyon for the first, or, so-called "Godless" Florin.

It is presumed that the introduction of the three varieties of coin named will be attended with some degree of trouble; but a royal proclamation legalizing them throughout the colony, and published both in the Chinese and English languages, will pave the way for their appearance, and the rest may be left to the accomplished and active Governor of Hong-Kong.

That the Chinese are not unwilling to adopt new systems and improvements which recommend themselves to their good sense has been clearly demonstrated in the colony by their patronage of the chartered banks established there. The notes issued by those banks are cashed freely in the province of Kwang-tung, seventy or eighty miles above Canton, by native bankers, and at a charge of not less than one-tenth per cent. This, at least, is a hopeful sign, and it leads to the supposition that, in due time, other reforms may be effected among the

Chinese, provided they be instituted and carried out in good faith, and with a proper deference to their time-honoured, though rather exceptional manners and customs.

It is well known that the Chinese are excellent calculators, and the universal employment of the abacus, or *swan-pan*, in the schools of the Celestial empire is, no doubt, the great cause of this. With that instrument, Sir John Bowring has told us, the Chinese youth has been as familiar as with his hemetrical classic, the first and most popular of his school-books. From it he has drawn the most correct impressions of the relations of numbers one to the other, and he has acquired the habit of moving the balls on the wires of his swan-pan with wondrous rapidity. For the performance of decimal calculations this instrument, which we need not further describe, is especially valuable, and it is an excellent forerunner therefore of a decimal coinage.

On the whole, there is every reason to hope that the British Government and the authorities of the Mint will gain golden opinions from both native and foreign residents at Hong-Kong, once the new coinage shall find its way into the channels and creeks of general circulation there.

URANUS.—SILVERED GLASS SPECULA.—OCCULTATIONS.

BY THE REV. T. W. WEBB, F.R.A.S.

URANUS.

If our readers have succeeded in finding Uranus, during a season when it has been almost an achievement to find anything, and still more, if they have effected the "raising of a disc"—that is to say, if its apparent magnitude has increased in the ratio of the magnifying power, which is never the case with the "spurious discs" of fixed stars—they have no reason to be dissatisfied. They have at any rate done what the celebrated Sir Joseph Banks, the President of the Royal Society for many years, failed to accomplish. The announcement of Herschel's discovery in 1781, though he considered it at the time to be probably a comet (its planetary nature being first suspected by Maskelyne), was received with some distrust; and I have been told by a friend (since deceased) of the discoverer, that the learned President, and several Fellows of the Royal Society, having been unsuccessful in searching for it, Sir William, then Dr. Herschel, had a portable tube constructed of silk, packed up his specula, left Slough, and gave the incredulous party

the meeting upon the roof of Somerset House, where, the planet having been duly exhibited, Sir Joseph Banks took off his hat and bowed to the illustrious astronomer, the others present following his example.

To advance beyond the mere exhibition of a disc would require a degree of optical aid which few amateurs have at command; it may therefore, perhaps, be interesting to state some particulars as to this remote body, the result of investigations with the most powerful instruments. There seems great probability that it may be really a flattened spheroid, as this form appears to be the ordinary concomitant, if not the result, of rotation upon an axis, and an unrotating planet would be an anomaly, the existence of which ought not to be admitted excepting upon the strongest evidence. This idea is also well borne out by the analogy of Jupiter and Saturn; for Uranus is evidently a member of the same group with those great planets. It is a fact worthy of notice, that the curious interval in which such a multitude of asteroids, or more properly "planetoids," have been discovered during the present century, divides the solar system into two very unequal portions—an inner and an outer region, each district being distinguished by characteristics of its own. All the planets beyond the dividing space, notwithstanding striking individual peculiarities, have certain common points of agreement, in which they differ from those of the interior group; such as great magnitude, inconsiderable density, and a numerous retinue of satellites.* When, therefore, we find so extensive a compression at the poles of Jupiter and Saturn, we should naturally expect a similar feature in the case of their next neighbour. Yet it is a question whether the amount of flattening, so conspicuous, even with small instruments, in those two great planets, is sufficient, in the case of Uranus, to be recognized even with the most powerful telescopes. Herschel, in 1782, considered the disc to be decidedly circular; in 1783,† 1792, 1794, and 1795, with various reflectors and magnifiers, he thought it slightly elliptical. Schröter, while contrasting it in 1802 with the newly discovered planet Ceres, speaks of its appearance, with his excellent $9\frac{1}{2}$-inch speculum, as that of a miniature Jupiter, except in the absence of ellipticity. Mädler, during some very fine weather in September, 1842, using a power of 1000 with the celebrated Dorpat achromatic, and measuring repeatedly 24 diameters at intervals of 15°, found a polar flattening $= \frac{1}{10 \cdot 85}$, with an inclination of

* Though only one satellite has been certainly discovered to attend upon Neptune, this will not be considered an exception, if we bear in mind the amazing distance of the object, and the great disproportion in magnitude which exists among the satellites of Saturn.

† This date has escaped the notice of Arago.

axis = 160° 40′: having repeated a similar process in 1843, he gave the mean result = $\frac{1}{9 \cdot 92}$. This would seem beyond exception; yet it is, though disappointing, instructive to find that it has not been confirmed by the yet superior instruments of Struve and Lassell. In 1787 and 1789, Sir W. Herschel strongly suspected the existence of two rings, not concentric like those of Saturn, but perpendicular to one another: in 1792, however, he abandoned the idea. This as well as the preceding instance, shows the degree of caution to be exercised in admitting as certain the indications even of the finest instruments, when the object approaches the limit of visibility. Excepting Lassell on one occasion, no one has ever surmised the presence of a spot upon this minute disc, and even he, with a 2-feet speculum, and in the sky of Malta, failed in verifying its existence.

Considering the small proportion of light which Uranus receives from a sun only 1′ 40″ in apparent diameter, and amounting to only $\frac{1}{370}$ of what we enjoy, its disc is more luminous than might have been expected; and hence Gruithuisen was led to suppose that it may, in common with Jupiter and Saturn, possess some native light. A more natural solution for the fact, which is certainly a curious one, especially in connection with the distribution, already mentioned, of the planets into two dissimilar groups, might be found in the supposition of a highly reflective material.

Those marvellous, but as it seems well-attested, peculiarities of the satellites of Uranus, the high inclination of their orbits to the ecliptic (amounting to 78° 58′), and their retrograde motion, so contrary to every known arrangement in the planetary system, would render them most interesting objects, if there were a chance of catching sight of them; but for ordinary amateurs the case is perfectly desperate. I do not know the smallest aperture which could grasp them. Smyth considered 5·9 inches utterly powerless. Lamont saw two plainly, and a third on one occasion, with the great achromatic in the Royal Observatory at Munich, having an 11-inch object-glass. From their extreme faintness much uncertainty has existed both as to their number and their distances from the primary. Sir W. Herschel thought he had discovered six; Arago, by including all the observations, however doubtful, of all the observers—the two Herschels, Lamont, Otto Struve, and Lassell—has made up eight; but evidently not much to his own satisfaction, nor, it may be presumed, that of any one else. In 1852 Lassell subjected Uranus to a long and most careful scrutiny, using a magnificent speculum of 24 inches in diameter, brought to such perfection by his own polishing machine, as to carry, in the air of Malta, a power of 1018 upon this feeble disc with "a remarkably hard

and sharp edge:" under these most propitious circumstances he was soon led to say, "I think it is high time that Uranus's establishment should be reduced. He has been luxuriating these many years with a retinue that I really believe does not belong to him, and therefore he must be cut down to four attendants, until some astronomer arises rich enough to present him with some more;" and his final conclusion was thus expressed:—"*I am fully persuaded that either he has no other satellites than these four* (viz., the two first seen by Sir W. Herschel, and two others added by himself), *or if he has, they remain yet to be discovered.*" From this decision there can be no appeal, excepting to the observer himself, who has now the fullest opportunity of revising it. He went out again more than twelve months ago to the same admirable station, with its hundred miles or more of sea in every direction, its equable temperature, and its peculiarly tranquil and transparent sky. He is armed with two still more superb specula of twice the diameter, and consequently four times the light-collecting capacity of his former one, and through the simple expedient of protecting them by a coat of varnish, their exquisite surfaces were preserved untarnished during the voyage. His observatory has been re-erected, and he has, it is known, long ago renewed his examination of Uranus. In the wish that in this, and all other respects, the result of his spirited expedition may answer his most earnest expectations, every reader of these pages will cordially join.

SILVERED GLASS SPECULA.

The old refracting telescope, of which there now remain so few specimens of any considerable size, that our readers may probably never have had an opportunity of seeing one, was by no means a contemptible instrument. The work that it accomplished in the hands of Huygens, Bianchini, Cassini, Maraldi, and other observers of the two last centuries, is a sufficient proof of its capabilities. While doing full justice to the admirable perfection of modern workmanship, we must feel that nothing can throw discredit on those who so fashioned the simple object-glass of former days that it could detect five of the satellites of Saturn, and show, even with an aperture of barely $2\frac{1}{2}$ inches, and a power of 90, the principal division of that planet's ring.* But however beautiful might be the figure and the polish of the lenses of Campani or Christian Huygens, the cumbrousness and unwieldiness of the machines which carried them were a

* I have seen, indeed, the latter object distinctly with a power of 80 on $3\frac{7}{10}$ inches, but only in such a way as to show that I possessed no great advantage over the original discoverers of that minute black line, which, according to De La Rue's measures, subtends an angle of only 0″·94, but to which W. Struve, Secchi, and Bond assign not so much as half that breadth—about 0″·4.

most serious drawback, and what we now call a "night's work" at an observatory would then have implied "work" indeed. The labour involved in such an undertaking may be estimated by any one who will look at the curious delineations appended to Bianchini's *Hesperi et Phosphori Nova Phænomena;* and though the ingenuity of Christian Huygens did something for observers in dispensing with the tube and all the marvellous appliances for bracing and stiffening it, the mere operation of getting the object-glass to a sufficient altitude was no trifle. So Derham found it when he had the loan of the 123 feet refractor, then, and still, belonging to the Royal Society: with characteristic simplicity he lays before the public his "chief inconvenience, the want of a long pole, of 100 or more feet, to raise my long glass to such an height as to see the heavenly bodies above the thick vapours. . . . . But, as I have been at considerable expenses already about these matters, and this I am informed would amount to £80 or £90, I thought it much too great a burden for the yearly income of my living."

The fate of such an apparatus was therefore not surprising when the invention of the reflecting telescope by Gregory and Newton, and of the achromatic by Hall and Dollond, reduced the length to one-tenth or one-twelfth part, without any sacrifice of distinctness. It sunk, never to be revived again; and ever since, the two constructions which superseded it have been competing for the preference. The reflector was the older, and in the hands of Short, about the middle of the last century, attained extraordinary perfection; but the achromatic, as the more convenient and less liable to injury, rapidly gained ground upon it, and would have quite outstripped it, but for the peculiar difficulty of procuring good glass. This was so great that even as late as 1829, Dollond had not been able to obtain a $4\frac{1}{2}$-inch disc of flint glass fit for such a purpose during the previous five years, nor one of 5 inches during twice the time; and hence the reflector maintained its superiority for the purposes of astronomical discovery. In the hands of Sir W. Herschel in England, and Schrader in Germany, the metallic speculum assumed gigantic proportions, and the rejection of the small mirror in the "front view" of the former was attended by an increase of light that for many purposes more than counterbalanced a slight want of accuracy in definition. But the achromatic was yet to have its turn. Fluids, as substitutes for the obnoxious flint glass, had not fully answered the purpose. Blair's beautiful adaptation of them had remained unnoticed, and seems to have been ill-suited to large apertures. Barlow's "correcting lens" of sulphuret of carbon had not been entirely satisfactory—it might possibly have been rendered so, but it came too late.

The difficulty had been conquered, though not by English opticians. Guinand had not toiled, and Frauenhofer had not shortened his days, in vain. Discs of fluid glass were manufactured of such magnitude and perfection, that the reflector, which with an equal aperture always returns less light than the achromatic transmits to the eye, lost its superiority, not only as a popular, but even as a scientific instrument. In a very few instances, such as those of the Earl of Rosse and Lassell, where labour and expense were disregarded, its enormous dimensions have kept it still ahead; but in the generality of observatories, public as well as private, achromatics have been adopted, of as large an aperture as circumstances would allow, reaching at Greenwich about $12\frac{3}{4}$ inches, and at the observatory of Poulkowa (the Czar's), Harvard (N. America), and Paris, nearly 15 inches.* This slight sketch of the present state of optical progress may serve to introduce a notice of a remarkable modification of the reflector, which has recently attracted the attention of astronomers, and will probably before long become more generally known.

Although it has been found that no metal is more suitable for such a purpose than the alloy of four atoms of copper to one of tin, commonly called *speculum metal*, which was hit upon at once by the extraordinary sagacity of Newton, and has never from that day been altered for the better, yet it has many and great disadvantages in the difficulty of casting it without pores, of cooling it without fracture, of working it without accident,† and of preserving its polish without injury; so that the field is open for much improvement. The obvious expedient of coating the back of a concave glass mirror with the alloy of mercury used for looking-glasses, would fail from the double image produced by reflection from two surfaces; and if the front of the glass were worked to a different curve, so as to get rid of this fault, the glass would become virtually a lens, and the error of colour—the great imperfection of the refractor—would be introduced; and though this might be removed, there would still remain an inevitable loss of light, and a risk of defects in material and centering. The front surface of such a glass mirror

* These are not the largest achromatics in existence; but Alvan Clark's grand $18\frac{1}{2}$-inch object-glass, valued at £2237, remains on the maker's hands in consequence of the war in America; and of the performance of Mr. Buckingham's, of 20 inches, the tube of which was so conspicuous in the International Exhibition, I have met with no detailed report. Mr. Craig's, at Wandsworth, of two feet, is well known to have proved a failure. No mention has been made of the very ingenious construction called the "Dialyte," well known on the Continent, because it has not, hitherto, attained such large dimensions.

† A large mirror of Herschel I. was broken merely by the frost; and the Earl of Rosse found that the same result would follow from melting cold resin upon a hot speculum, or touching it, when cold, with an iron tool but little warmer than itself.

would be free from all these objections were it coated with metal (for its own reflective power would be quite inadequate, except as a "helioscope," for viewing the sun); but then that alloy would be worthless, as it would take no polish in contact with the air. But it has been known for some years among chemists that by the addition of certain essential oils to a solution of nitrate of silver while it is undergoing decomposition by ammonia, the pure metal is precipitated on the surface of glass in the state of a film, so thin as to be feebly transparent to a powerful light, yet so firm as to receive a superb polish, and so reflective as to return, when compared with the best speculum metal, nearly *half as many again* of the incident rays. The applicability of this discovery to telescopes was perceived by Steinheil, of Munich, the ingenious rival of the great Frauenhofer's successor, Merz, in 1856; and in less than twelve months afterwards, independently, by M. Léon Foucault, of Paris. The former has advertised telescopes on this construction up to nine and a-half feet focus and twelve and three-quarter inches aperture; the latter has wrought a similar aperture to such a degree of excellence as to divide the well-known test, the companion of γ *Andromedæ*; and repeated notices may be found in the present work* of a still more magnificent instrument, of about thirty-one inches, from the same hand, worthily entrusted to the care of M. Chacornac, at the Imperial Observatory of Paris.

The numerous advantages of this construction will be readily apparent:—1. Large discs of glass may be cast much more free from pores and minute defects than corresponding masses of metal. 2. With an equal aperture they need not have more than one quarter of the weight; a very important consideration when we bear in mind the unwieldiness of very large instruments, and that the six-feet metallic speculum of the Earl of Rosse weighed no less than four tons. 3. They will be far less liable to change their figure in consequence of their own weight, or of any accidental strain or pressure; a matter of great consequence, as we find, from Sir John Herschel's statement, that an eighteen-inch speculum, two inches thick, was totally spoiled by supporting it on three points at its circumference, or by making it recline against a piece of wood, with a single thin packthread interposed down the middle, and Lord Rosse's experience, that even six inches of thickness, with six feet in diameter, would not secure correctness of figure, under a strong pressure of the hand. 4. They possess an inestimable advantage in being always renewable without injury. Should the surface of metal become tarnished, the defect can only be remedied by repolishing, a process which, except in the most accomplished

* Intellectual Observer, iv. 324; v. 380; vi. 481; xii. 420.

hands, is always attended with some risk of injuring the accuracy of the figure, and which, in those rare cases where extraordinary perfection is accidentally attained, would hardly be ventured upon at all; while, on the contrary, the silver coating may be removed or replaced at pleasure without in the least affecting the form of the glass, which, when once brought by repeated trials to the highest excellence attainable by art, will remain unchanged (provided the material itself is sound) for any assignable length of time. 5. The reflective power of the silver film is not only far greater than that of the most perfect speculum-metal, but the amount of light, with equal apertures, if we may trust the results of Steinheil's investigations, actually surpasses that of many achromatics—his numbers expressing the proportion of available light being, for the ordinary reflector (front view, as it would appear), 67·18; for Frauenhofer's achromatics, 76·0; for his own, 86·67; for the silvered mirror, 91·08, which the addition of a reflecting prism, on the Newtonian arrangement, might probably reduce to 84·4, or 79·0, according as we adopt the transmissive power of Steinheil or Frauenhofer's glass—at a mean somewhere about 81·7, a degree of brilliancy nearly half-way between the achromatics of Frauenhofer and Steinheil.

It would have been a mortifying conclusion to such an enumeration of advantages if we had been obliged to add that this beautiful invention was not merely due to foreign ingenuity, but was monopolized by foreign manufacturers. This, however, is not the fact. We shall not be long indebted for our knowledge of it to the small specimens, about four inches in diameter, which are sent over to England, by Sécrétan, the successor of Lerebours, at Paris, and sold in London by Negretti and Zambra. M. Foucault has, with praiseworthy liberality, published every step of his process in the *Annales de l'Observatoire Imperiale*, tom. v.; but other methods, it is found, will lead to the same result, and several of our countrymen are engaged in the pursuit, with an intelligence and perseverance which are sure to be rewarded in the end. It is now some time since it was stated that Mr. Hodgson (the observer of the brilliant spot in front of the sun) had communicated his experience to the Astronomical Society; and at the present moment Prof. Frankland, of the Royal Institution, the Rev. H. C. Key, of Stretton Rectory, Herefordshire, Mr. With, of Hereford, and Mr. Bird, of Birmingham, may be named as having made considerable progress towards complete success. In a future number we hope to lay some of their results before our readers.

OCCULTATIONS.

Besides that of 5 Cancri on March 1st, introduced into the list of last month, we have only two to indicate at convenient times. March 2nd, *a* Cancri will be occulted from 11h. 49m. till 13h. This will be interesting from the large size (4 mag.) of the star. The other is on March 30th, when ω Leonis, 6 mag., will be hidden from 11h. 44m. till 12h. 53m.

THE ANTIQUITY OF MAN.

Those who have elevated their minds to the faintest approximate conception of the boundless diversity and complexity which the universe displays in the combination of its materials and forces, will be prepared to expect that research will continually conduct them to surprise. The widest generalizations to which science has attained embrace so small a portion of the majestic whole, and so much of commonly received opinion rests upon no adequate foundation, that he can inquire little who does not continually meet with facts that cannot be accommodated to the hypotheses he has entertained; nor can we have a better test of the degree of cultivation of an individual, or of a society, than is afforded by examining the amount of readiness that exists to exchange old prejudice for new truth. Barbarous ages stone their prophets, because it is the tendency of ignorance to imagine that it is infinitely wise. It remains for intelligence to perceive its own feebleness, and for the loftiest reason to be the most convinced that it must fall short and fail to reach "the portals of Divinity," whether the subject of its contemplations be the work of creation in the physical history of a planet, or the functions and destiny of a mind. Where knowledge is obviously incomplete, belief should be provisional, and the judgment trained to hold itself in the prudent suspense of philosophic doubt, while the inquiring faculties are busy collecting the materials on which a final decision may be ultimately formed.

For some years past geologists have acted prudently in their treatment of the accumulating evidence of the antiquity of the human race. They have opposed a moderate, but not a fanatical, resistance to the incursion of new ideas. They have subjected every known fact bearing upon the question to a rigorous investigation, and they have not invited the general public to share their speculations until they rested upon so firm a basis that, although certain details were disputed, the

general bearing of the argument could not be gainsaid. If the last generation had been aware that any body of men were engaged in so formidable an attack upon prevalent ideas, a prodigious outcry would have been raised; but in our time the process has been allowed to go on quietly, partly because every other body of intelligent searchers into the history of the past has been led to analogous conclusions, and partly because there is happily less disposition than formerly to battle with truth as an enemy, before receiving her as a friend. Palæontologists and physiologists have made increasing drafts upon the bank of Time to enable them to trace the changes which organized beings have undergone; ethnologists have demanded the lapse of long ages to explain the phenomena of the modifications of race; and the new school of scientific historians have referred the civilization of early empires to periods far more distant than the epoch which was once thoughtlessly assigned to the creation of the world.

The geologist can do little in estimating the exact number of ages that have elapsed since the flint implements were fashioned by the savages in the valley of the Somme, but he can show those antique representatives of humanity to have been associated with animals that became extinct long before the earliest known works of Egypt were constructed, and to have lived at a time when the physical conformation of the globe's surface was widely different, not only from what it is now, but what it was in any pre-historic age of which tradition has preserved the faintest trace. It may be asked why no proof of these facts was obtained before the present day; how it happened that the innumerable excavations of man, or the natural cuttings by rivers, or seas, did not unrol the records of the human past? and the answer is easy. The geological record resembles rather stray leaves than a perfect book; it is only in rare and exceptional cases that nature preserves in her stone cabinet the relics of organic beings, and it is only a very few of the total number of her preparations, or, to preserve our metaphor, of the drawers containing her collections, to which access has been allowed. Our knowledge of specific forms is often derived from a single formation of very limited extent, and as an instance of what may unexpectedly turn up, we may remark that thousands of fossils have been extracted during several generations from the Solenhofen quarries without the slightest indication that they would one day surrender the extraordinary bird-reptile, or reptile-bird, figured and described in the last volume of this work. It must also be considered that many intimations of man's antiquity were of little value until others had been obtained. A single fact is often dumb when a group can be made to speak.

The long-announced and long-expected work of Sir Charles Lyell* has admirably brought to a focus the scattered information concerning our early progenitors, and it is still further enriched by the details of his own researches, and the careful reasoning of his own capacious and prudent mind. As Sir Charles Lyell observes, the only formations concerned in the present inquiry are those of the most modern date, or Post-tertiary; and he remarks, "It will be convenient to divide these into two groups—the Recent and the Post-pliocene. In the Recent we may comprehend those deposits in which not only all the shells, but all the fossil mammalia are of living species; in the Post-pliocene those strata in which, the shells being recent, a portion, and often a considerable one, of the accompanying fossil quadrupeds belongs to extinct species." The human remains of the Recent period, which form the subject of discussion, have been found in Danish peat mosses, in the beds of Swiss lakes, in certain artificial islands in Ireland, in Scotland, and various other parts of the globe, while those of the earlier epoch belong to Belgium, Germany, France, and England.

The peat bogs of Denmark have been formed in depressions of the drift formation, and they contain trunks of the Scotch fir often three feet in diameter, "which must have grown on the margin of the peat mosses, and have frequently fallen into them. This tree is not now, nor has ever been in historical times, a native of the Danish islands, and when introduced there has not thriven." It further appears to have been supplanted by the sessile variety of the common oak, which has been in its turn replaced by the beech. Thus, extensive changes in the vegetable world, resulting from alterations of soil and climate, must have taken place since the Danish savages lived, who made the rude implements of the stone period that are discovered in the bogs.

Another class of objects in Denmark, the "shell mounds," offer their testimony to the antiquity of the rude hunters and fishers by whom they were formed. The Danes call these accumulations "kitchen heaps." They are, in fact, the refuse of pre-historic dinners, and are associated with "flint knives, hatchets, and other instruments of stone, horn, wood, bone, and fragments of pottery." The "most conclusive proof" of the antiquity of these heaps is found in the character of the imbedded shells. At present, the quantity of fresh water poured into the Baltic is so unfavourable to oysters, cockles, mussels, etc., that they are either dwarfed or entirely excluded from that inland sea; but the old fishermen were able to obtain large specimens in great quantities, which shows a dif-

* *The Geological Evidences of the Antiquity of Man, with Remarks on Theories of the Origin of Species by Variation.* By Sir Charles Lyell, F.R.S. Murray.

ferent condition in the physical geography of the locality, so as to permit a freer access to the salt water of the ocean than now occurs. The shell mounds correspond in date, says Sir C. Lyell, with the earliest part of the age of stone, as known in Denmark. Later than this comes the so-called age of bronze, and that must have been very ancient in a chronological point o view.

The ancient lake dwellings of Switzerland were the abode of a race who built their habitations on piles surrounded by water. Some remains of this class belong to the stone period, and others to the bronze. Among the profusion of relics of these singular people is a human skull of the early stone period, and much like those belonging to the Swiss of the present day. All attempts to convert geological time into its chronological equivalent must be received with caution, but Sir C. Lyell attaches some weight to the calculations of M. Morlot, who, "assuming the Roman period to represent an antiquity of from sixteen to eighteen centuries, assigns to the bronze age, as disclosed in a delta of the Tinière, a date of between 3000 and 4000 years, and the oldest layer (of the same formation), that of the stone period, an age of from 5000 to 7000 years."

Passing over researches in Ireland, Egypt, and Brazil, we come to the delta of the Mississippi, to which Sir C. Lyell assigns an antiquity of probably more than 100,000 years. At a certain depth in this formation a human skull was discovered of the type of the red Indian race, and to this Dr. Dowler ascribes an antiquity of 50,000 years. In the coral reefs of Florida human bones were found by Count Pourtalis, in a conglomerate, calculated by Agassiz to be 10,000 years old.

The reader who desires to see a more perfect chain of evidence than we have adduced in the preceding paragraphs, to show that man lived in a period which, although geologically very modern, is still chronologically extremely old, is referred to Sir C. Lyell's work, from which we proceed to extract proofs that the human family may be traced back to a still earlier time, when certain mammalia that are now extinct inhabited the earth. In 1833-4, Dr. Schmerling published an account of his researches in caverns near Liège, which led to the discovery of human bones associated with the bones of the cave bear, hyæna, elephant, and rhinoceros, which are extinct, and with other bones of animals still extant. In the Engis cavern a human skull was found embedded by the side of a mammoth's tooth. This skull was so fragile that it could not be preserved, but a more fortunate specimen, now in the museum of the University of Liège, was dug out of a breccia at the depth of five feet, and was associated with the tooth of a rhinoceros, the

bones of a horse, and other animals. Other caves likewise yielded human remains; but Dr. Schmerling remarked that out of about forty which he explored, flint implements were universal, although human bones were the exception. These discoveries did not attract the attention which they merited, because few geologists were disposed to modify their ideas on the antiquity of the human race, or to admit the fact that the comparative date they had been pleased to assign to it rested upon no adequate support.

In 1860 Sir C. Lyell visited the scene of Schmerling's investigations, and found that the caves of Engis, Chokier, and Goffontaine had been completely destroyed: part of the Engihoul cavern, however, remained, and it was explored by our distinguished countryman in company with Professor Malaise. They soon found bones and teeth of the cave bear and other extinct quadrupeds, and the continuance of the examination by Professor Malaise was rewarded in a few weeks by the discovery of three fragments of a human skull, and two perfect lower jaws with teeth, at a depth of two feet below a crust of stalagmite, and again associated with the bones of extinct animals.

The antiquity of such remains must be computed by estimations of the time which must have intervened between the period when certain races of animals were common and that at which they became extinct, and also by the ages required to produce considerable changes in the configuration of the country, as under existing circumstances the caverns could not have been, as they once were, the receptacles of materials carried along and rounded by streams or floods. Some of the fossiliferous caverns "now open in the face of perpendicular precipices, 200 feet in height above the present streams," and there are other evidences of such extensive alterations as to leave no doubt that an immense lapse of time is required to account for them, even with the aid of the probable supposition that disturbing agencies were far more active in some former period than at the present time. Sir C. Lyell makes no attempt to say how long ago the ancient Belgians flourished, but he observes that "although we may be unable to estimate the minimum of time required for the changes in physical geography above alluded to, we cannot fail to perceive that the duration of the period must have been very protracted, and that other ages of comparative inaction may have followed, separating the Post-pliocene from the historical period, and constituting an interval no less indefinite in its duration."

The next instance cited by Sir C. Lyell refers to the fossil human skeleton found in 1857 in the cave of Neanderthal, near Düsseldorf, about seventy miles N.E. of the Liège caverns.

The Neanderthal cave is sixty feet above the level of the river Düssel, and 100 feet below the surface of the country, with which it communicates by a rent, forming an ascending channel. Professor Huxley pronounced the skull obtained from this cave to be the most ape-like he had ever beheld. The last-named Professor observes that "cranial measurements alone afford no safe indication of race," and he shows that the skulls of Australian savages prove that great differences of development may co-exist in a race that is remarkably pure and unmixed. Sir Charles Lyell remarks that the Engis skull has caused surprise, "because, being so unequivocally ancient, it approached so near to the highest, or Caucasian type; that of the Neanderthal, because, having no such decided claims to antiquity, it departs so widely from the normal standard of humanity."

Human remains in Brixham cave and other places combine to enforce man's claims to a part diuturnity as an inhabitant of the globe, and as fresh evidence has been collected, attempts to give an opposite interpretation to geological facts have been received with diminishing favour, until there is not now any existing authority of eminence whose opinions could be cited against the general conclusions embodied in Sir C. Lyell's work. This result has been much accelerated by the discoveries of flint implements in the valley of the Somme; and although these researches have only attracted the very recent attention of the general public, they have been carried on for many years, and have successfully passed the ordeal of prolonged investigation and dispute.

Condensing Sir Charles Lyell's description of the locality, we find the valley of the Somme situated in a region of white chalk with flints, the strata of which are nearly horizontal, and the hills from 200 to 300 feet high. Ascending to that height discloses a table-land, in which the chalk is mostly covered by loam about five feet thick. A section of the valley shows the underlying chalk at the bottom, then a bed of gravel, on which lies twenty or thirty feet of peat. A gravel bed covered with loam rises on one side of the valley, a little above the peat, and still higher on both sides is an upper gravel bed, which, like the lower one, contains elephants' bones; above this an "upland loam," and still higher Eocene tertiary strata, resting on the chalk in patches.

The peat constitutes the most modern of the formations just described, and is about thirty feet thick. It abounds in mammalian bones, but "M. Boucher de Perthes has only met with three or four fragments of human skeletons." So large a mass of peat, whose formation is always very slow, must have occupied a lengthened period, and it was obviously formed after the

deposits in which the flint implements have been found. At Menchecourt, Abbeville, many flint implements have been found in a position which Sir C. Lyell explains by a diagram. First we find a hollow in the slope of the chalk, exhibiting a "bed of brown clay with angular flints and occasionally chalk rubble, unstratified, probably of sub-aerial origin, of very varying thickness, from two to five feet and upwards." Below this comes a calcareous loam, containing fresh water and land shells, with bones of elephants, etc.; thickness about fifteen feet." Underneath this "alternations of beds of gravel, marl, and sand, with fresh water and land shells, and in some of the lower sands a mixture of marine shells; also bones of elephant and rhinoceros, and flint implements; thickness about twelve feet. At a lower level in the valley is the bed of gravel on which the peat rests, separated by a thin bed of impervious clay. The age of this gravel and its precise relation to that in which the flint implements were found is not ascertained.

In such a case as this the age of the flint implement deposit must be estimated with reference to the amount of natural work that has been done in the locality since its formation, and the evidence will be partly derived from the thickness and character of the strata deposited upon it, partly from the quantity of matter that must have been removed to give the valley its present appearance, and partly from the extent of changes which fossil remains prove to have occurred in organic life. Into this calculation we cannot enter, but history and observation show that alluvial formations are of such slow growth that many centuries count for little when extensive changes have to be explained.

No one having the slightest acquaintance with geological facts would deny the enormous antiquity, chronologically speaking, of the flint implement deposits of the Somme; but two important objections have been made. It was said that the so-called implements were natural fragments of flint, and that if their shape was due to human skill, some accident had deposited them in a stratum older than themselves. Both these difficulties have been met; archæologists and geologists are now agreed that they are veritable works of man, and repeated examination precludes the idea of their being modern productions accidentally misplaced. Professor Ramsay observes, "for more than twenty years, like others of my craft, I have daily handled stones, whether fashioned by nature or art; and the flint stones of Amiens and Abbeville seem to me as clearly works of art as any Sheffield whittle." We ought to add that Mr. Prestwich, who is remarkable for his acquaintance with formations of this kind, obtained, as did others, conclusive evidence that the flint implements existed in undisturbed beds

of gravel, and had not made their way into them from any newer deposit. England has yielded flint implements like those of the Somme: some have been found in the basin of the Thames, but their geological position has not been made out; and others occur in the gravel pits of the valley of the Ouse, near Bedford, and certain localities in Suffolk.

We have thus given a very incomplete summary of the geological evidence on which a far greater antiquity is claimed for man than a guess-work system of modern chronology has assigned to him, and it is remarkable that the science of modern Europe is thus rescuing from ignominious treatment the historical traditions of ancient races, and restoring them to their true place, as more or less reliable contributions to our acquaintance with the distant past. In France M. Rodier* has endeavoured to make astronomy the means of testing and estimating ancient dates, and he affirms that the Egyptian period of Osiris is approximately proved to coincide with 19,564 B.C., and the era of Ma he considers shown by "very precise astronomical indications" to have commenced in 14,611 B.C. We offer no opinion as to the validity of M. Rodier's process, but his work is one of many indications of a disposition to collate and respect the teaching of long neglected facts, and however far back his calculations may place the dawn of civilization on the banks of the Nile, it will still appear as a modern period when compared with the epoch during which England was united with France, and the men of the flint implements contended with wild beasts whose race has been long extinct.

Each mind must decide for itself how far its speculative opinions may be affected by these considerations; but, as Sir Thomas Brown observed with reference to his own scientific inquiries, "there is no danger to profound these mysteries, no *sanctum sanctorum* in philosophy: the world was made to be inhabited by Beasts, but studied and contemplated by Man; 'tis the debt of Reason we owe to God, and the homage we pay for not being Beasts. . . The wisdom of God receives small honour from these vulgar Heads that rudely stare about, and with gross rusticity admire his works; those highly magnify Him whose judicious inquiry into his Acts and deliberate research into his Creatures return the duty of a devout and learned admiration."†

* *Antiquité des Races Humaines, Reconstitution de la Chronologie et de l'Histoire des Peuples Primitives, par l'Examen des Documents Originaux et par l'Astronomie.* Paris, Amyot.

† *Religio Medici*, ed. 1686, p. 7.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY.—*Jan.* 21, *Feb.* 4, *and* 20.

On the Parallel Roads of Glen Roy.—Professor Jamieson read a paper on the formation of these roads and their position in the history of the Glacial period.

After describing the general appearance of the roads, the author referred to the different theories that have been framed to account for them, giving his reasons for considering both the marine hypotheses untenable, and pointing out the evidences in favour of Agassiz's theory of a dam of glacier-ice having supported a fresh-water lake. He especially dwelt upon the coincidence between the height of each of the parallel roads and that of a neighbouring water-shed, but also remarked upon the objections to a glacial barrier, explaining how it might have shrunk at three successive periods, so as to allow of the formation of the three roads. He then showed that the period of the formation of these roads must either have been posterior to that of the chief submergence of the drift-period, or that the sea did not reach them during the submergence; also, that it was prior to the formation of the 40-feet raised beach of Argyleshire.

Professor Jamieson concluded by stating that his examination of Lochaber had led him to infer that the parallel roads are the beaches of ancient fresh-water lakes, which arose from glaciers damming the mouths of the valleys and reversing their drainage, at a date subsequent to that of the great land-glaciation of Scotland, owing to a re-extension of the glaciers after the chief submergence of the Drift period.

On a Hyæna-den at Wookey Hole, near Wells. By W. Boyd Dawkins, Esq., B.A., F.G.S., of the Geological Survey of Great Britain.

The former partial exploration of this cave by the author convinced him of the desirability of a more rigorous examination, the details of which were given, showing the distribution of the teeth and bones of the species of *Mammalia* whose remains were met with in the several parts of the cave, and a statement of the general results arrived at. A consideration of the distribution of the remains in the cavern and their close juxtaposition to the roof, coupled with the fact that the flint and chert implements discovered were found in much lower positions, led Mr. Dawkins to infer that the bones had been dragged in by hyænas, and that the cave had been subjected to periodical inundations of waters laden with red mud, whereby the bones had been elevated by degrees until they occupied their present position.

The Anniversary Address was delivered on the 20th February, by the President, Professor Ramsay, the subject being the "Breaks

in the Succession of British Strata." The remarks were chiefly directed to the Palæozoic formations, and evidence was adduced to show that the epochs not stratigraphically represented in our islands were of longer duration than those which are so represented. From these premises the Professor argued that the apparent breaks in the succession of living forms were to be accounted for by the incompleteness of the record, and not by theories of violent destructions and new creations, which were not borne out by known facts. Nor was it just to assume that we saw the dawn of life in the earliest British strata, especially as older corals had been discovered in Canada.

Professor Ramsay likewise adverted to the question of whether similar formations in distant countries were contemporaneous, and stated his opinion that in many cases the length of time occupied in the disposition of Palæozoic strata was so enormous as to have rendered a very wide migration of species possible, and to make it probable that similarity of organic remains indicated an approximation of date.

ROYAL GEOGRAPHICAL SOCIETY.—*Jan.* 26.

The first paper, "On a Proposed Route to Siam, China, etc., across the Isthmus of Kraw, by Captains Fraser and Forlong," was communicated by Dr. Duncan Macpherson, F.R.G.S., etc., etc. The paper set forth the advantages to be derived by constructing a railway through the neck of land in the Malay Peninsula, known as the Isthmus of Kraw. The saving in time between Calcutta and Hong-Kong by this route would be ninety-three hours; and fifty-six hours would be saved from Ceylon to Hong-Kong; touching at four ports, viz. Akyab, Rangoon, Moulmein, and Kraw: while coasting it from Calcutta to Hong-Kong, thirty-four hours will be saved over the present route, viz., Singapore.

From Ceylon to Kraw, and thence direct to Calcutta, *two extra* English mails may be carried in nine and a half days to the mouth of the Hooghly, necessitating only one extra steamer between Ceylon and Aden, to meet the Bombay mail.

Mr. John Crawfurd observed that the so-called Patchkau River, which was said to be navigable for fifteen miles, was simply an estuary of the sea, with a depth of four or five fathoms for half the distance, and of but a fathom and a half for the remainder. Then at the eastern terminus of the proposed railway there was no harbour, and the shore was moreover exposed to the north-eastern monsoon. With these disadvantages the route in question would never serve as the transit for the great trade between Europe, India, and China. Nor, if practicable, would the small saving of time to be gained justify the great outlay that must be incurred. In reply to the alleged dangerous navigation of the Straits of Malacca, Mr. Crawfurd stated that during a period of eighteen years, the Peninsula and Oriental Company had lost only two ships in the Straits, and that arose from a collision in the dark; that out of three hundred voyages made by steamers from Calcutta and Bombay, not a single vessel had

been lost; and that no instance had occured of the loss of any of her Majesty's steamers, nor of any of the vessels despatched fortnightly by the Dutch Government, which had passed through these Straits.

Mr. Lawrence Oliphant, F.R.G.S., then read his paper on the Island of Tsusima, Japan. After a short allusion to the inland sea of Japan, Mr. Oliphant gave an account of a visit to Tsusima, an island lying midway in the Straits of the Corea. Fatchiu, the capital, contains 10,000 inhabitants. The Prince's palace is situated near the town. He is absolute proprietor of the island, and has a monopoly of the transit trade between the Corea and Japan, which consists chiefly in tigers' skins, hides, rice, silver, and gold. The island is about forty miles long, from eight to ten broad, and contains a population of 30,000. It is hilly, the highest peaks attaining an elevation of upwards of 2000 feet; they are heavily timbered. The island is almost bisected by a deep sound, from which numerous deep fiords diverge. The fleets of the world might be concealed in this labyrinth of inland waters. As yet our knowledge of the interior of the island is very limited. Its position between Corea and Japan renders it important.

Sir Rutherford Alcock stated that the island of Tsusima was of some interest to him when he was in Japan, from the proceedings of the Russians in that quarter. It was known that they had for some time made it a sort of naval port for carrying out most extensive repairs to their ships; and it was therefore desirable to ascertain whether the island enjoyed advantages which might be fairly shared by other nations. The reports which had been received convinced him that there is no part of the Chinese seas which could be chosen with so much advantage as this magnificent harbour in an unfrozen sea, capable of being made defensible against attack, and of serving as a place of resort for fleets in distress. Sir Rutherford dwelt particularly upon the extraordinary accuracy of the Japanese maps and charts.

The President called attention to the reported death of Mr. Consul Petherick and his wife on the White Nile, and after expressing the deep regret which every geographer must feel at the death of these travellers, stated that the money which remained out of the subscriptions raised to enable assistance to be sent to Captains Speke and Grant, the Council had resolved to place in the hands of Mr. Baker, who was about to proceed into the interior from Khartum at his own expense, and to request him to pursue the expedition with which Mr. Petherick had been entrusted.

ETHNOLOGICAL SOCIETY.—*Feb.* 3.

On the Psychological Differences which Exist amongst the Typical Races of Man, by Robert Dunn.—The author maintained that genus *homo* was distinctly defined, on the ground that in man's moral and religious attributes the inferior animals do not participate, and it was this that constituted the difference between

him and them. The barrier was thus, he considered, impassable between man and the chimpanzee and gorilla; and that wherever man, with his erect attitude and with his articulate voice, is found, his claims to our common humanity must be immediately acknowledged, however debased the type may be. His conviction was that there was proof of a general unity exhibited in all the races of the great family of man, inasmuch that they were all endowed with the same intellectual faculties and mental activities, however much they may vary in degree. It had, he thought, been fairly argued that all the races of the human family form but one species, from the physiological fact that they are all capable of fruitful union. Believing the brain to be the material organ of the mind, the author considered the study of the cerebral organization and development in the various typical races as one of the most effectual means of better understanding and elucidating the psychological differences which characterize them. This subject, however, was one that yet required to be worked out; and ethnic psychology was still a desideratum. The author then reviewed what had been done by anatomists and ethnologists, and pointed out that the lower savage races, such as the Sandwich islanders, made progress in the early part of their education, and were so far as apt and quick as the children of civilized Europeans; but at this point they stopped, and seemed incapable of acquiring the higher branches of knowledge. The Sandwich islanders have excellent memories, and learn by rote with wonderful rapidity, but will not exercise the thinking faculties; they receive simple ideas, but not complex ones. In like manner it was found practically that negro children could not be educated with white children. In all these cases, as well as in the minor ones continually occurring amongst ourselves, of inability to understand subjects and reasonings of a certain order, the true explanation is that the cognate faculties have not reached a complexity equal to the complexity of the relations to be perceived; as moreover it is not only so with purely intellectual cognitions, but it is the same with *moral* cognitions. In the Australian language there are no words answering to justice, sin, guilt. Amongst many of the lower races of man, acts of generosity or mercy are utterly incomprehensible; that is to say, the most complex relations of human action in its social bearings are not cognizable. This the author thought was in accordance with what *à priori* might have been expected to have resulted from organic differences in the instruments of the higher psychical activities—or, in other words, in the nervous apparatus of perceptive and intellectual consciousness. The leading characters of the various races of mankind were simply representatives of particular stages in the development of the highest Caucasian type. The negro exhibits permanently the imperfect brow, projecting lower jaw, and slender bent limbs of a Caucasian child some considerable time before the period of its birth. The aboriginal American represents the same child nearer birth; the Mongolian the same child newly born.

LINNÆAN SOCIETY.—*Feb.* 5.

On the Existence of the Two Forms in some Species of Linum.—A paper by Mr. C. Darwin was read, on the existence of two forms in several species of the genus Linum. In the Linum grandiflorum these two forms occur in about equal numbers; in general appearance both are alike, but closer examination shows that in one the styles are short, and diverge to such an extent that they are thrust out between the filaments, not being long enough to reach the anthers. In the other form the styles are very much longer, and stand perfectly erect, occupying the centre of the flowers. So far as can be ascertained by microscopic examination, the pollen of both forms appears identical in structure. In the year 1861, eleven plants of Linum grandiflorum were growing in Mr. Darwin's garden; of these eight were long-styled and three short-styled. Of the long-styled plants it was ascertained that when the stigmas were covered with pollen from long-styled flowers, they invariably remained sterile, but that when fertilized with pollen from the short-styled variety, they produced abundance of seeds. Of the short-styled form it was found that they were rather more fertile with their own pollen than the long-styled; but it was thought possible that this might be dependent on pollen from the long-styled flowers being conveyed by means of the small dipterous insects that frequent the species. In the year 1862, Mr. Darwin experimented on plants which were protected from insect agency. Fourteen long-styled flowers fertilized with short-styled pollen, produced eleven perfect capsules. Whereas one hundred long-styled flowers, fertilized with pollen from the same form, produced only three capsules, and these were imperfect.

In the short-styled form, of twelve flowers impregnated with pollen from the long-styled variety, seven produced perfect capsules containing seeds, as contrasted with one hundred with their own pollen, of which only eleven produced seed. Thus it appears that there is a slight difference between the two forms, the long-styled being perfectly sterile with its own pollen, whereas the short-styled is only partially so. Microscopic examination and dissection show that when the pollen grains from the short-styled variety are placed on the stigmas of the long-styled flowers, they burst in about five or six hours, and emit long tubes, which can be traced down the tissue of the style, and that in about twenty-four hours the stigmas wither, showing that their function has been fulfilled. When, however, the pollen of the long-styled flowers is placed on stigmas of the same form, only a very small number of the grains burst, and the tubes emitted by them do not penetrate more than a very short distance into the tissue of the stigma. Thus it appears that the stigma of each variety is perfectly powerless over pollen of the same variety, but that simple contact with the stigmatic surface causes the pollen of the opposite form to emits its tubes.

It would be difficult to overrate the value of the contributions with which Mr. Darwin has lately enriched Botanical Science. The present

is of immense value, not only for the positive information which it affords on a subject altogether so novel and interesting, but also because it shows young naturalists how much may be done in the study of the simplest and most common organism, provided this be carefully and conscientiously carried out. To those botanists who believe that botanical science consists in a mere knowledge of the names of numerous species, and that it is to be mastered by merely collecting and cataloguing plants, we commend the recent investigation of the illustrious author as an example worthy of all imitation.

SOCIETY OF ARTS.

A pressure upon our space has prevented our giving earlier notice to Mr. Highley's lecture at the above Society on "The Application of Photography to the Magic Lantern Educationally Considered." The object was to exhibit the excellent apparatus and slides prepared for the illustration of lectures on a variety of subjects. Mr. Highley explained his mode of procedure at considerable length, and obtained much applause for the merit of his results. His arrangements for a portable oxy-hydrogen microscope particularly deserve commendation.

Mr. Highley has since opened the Burlington Gallery, 191, Piccadilly, for the display and sale of his photographic slides. We were present on the first evening, and were especially pleased with some admirable instantaneous vews of Paris, and Kaulbach's scenes from Reynard the Fox. Some of the scientific representations were very good, but photography is only partially successful in giving the textures of rocks, and Dr. Maddox's diatoms are unsatisfactory.—[Ed. *I. O.*]

ROYAL INSTITUTION.—*Feb.* 13.

On Artificial Illumination.—Dr. Frankland in his lecture on the Artificial Illumination, described the formation of the new compound, *Acetylene*, which is produced when coal gas is highly heated. This is strongly illuminating, and is interesting as forming an explosive compound with copper; thus explaining the cause of the mysterious explosions that have not unfrequently occurred when coal gas is passed through copper tubes. In speaking of the economy of the different illuminating agents, Dr. Frankland stated that by recent experiment he had ascertained that one gallon of mineral oil was equal to 18 pounds of paraffin candles, 22 pounds of sperm, 26 of wax, 27 of stearine, 29 of composite, and 39 pounds of ordinary tallow candles.

NOTES AND MEMORANDA.

Nerves of the Liver.—We see from the *Proceedings of the Royal Society* that Dr. Lee has demonstrated that all the arteries—even the most minute—which ramify in the liver, are accompanied by nerves which take their origin from ganglia round the root of the hepatic artery, and which are intimately connected with, or form part of, the semi-lunar ganglion of the great sympathetic.

Solvent for Silk.—M. Persoz describes in *Comptes Rendus* his process for dissolving silk. He uses a concentrated solution of chloride of zinc, which has been boiled with an excess of the oxide of that metal until it does not discolour litmus. By means of Professor Graham's dialyser, the silk can be separated from the chloride of zinc, in the form of a colourless, inodorous solution, which gives an evaporation, a green-coloured brittle varnish. The chloride of zinc offers the means of separating the silk from mixed fabrics.

Plasticity of Blood Corpuscles.—Dr. Sharpey says:—"The plasticity of the blood corpuscle is unrivalled by any other physical body. It will assume all sorts of protean shapes under the slightest influences. Elongating to a mere thread, it will pass through a narrow chink; it will wrap itself round an acute projecting angle, or protrude feelers and tails under the influence of currents. In its natural state, it possesses sufficient elasticity to resume its original shape on the cessation of the modifying influences; but when gum or gelatine has been added, or when the plasma has been permitted to thicken spontaneously, the corpuscle retains any form it may have assumed till again altered by fresh influence."—*Proceedings of the Royal Society*, No. 52.

Black Rain in South America.—(From the *Mercurio* of Valparaiso, December 17, 1862.)—A strange phenomenon has been seen in one of the Argentine Provinces. The *Comercio del Parana* describes it as follows:—"On the 12th inst. (December), about seven A.M., it became so dark that in many houses in this city (San Juan) lamps had to be lighted; it soon began very slowly to clear up, but the day remained cloudy till about two p.m., accompanied by strong gusts of wind. During the night it rained *black water*. Some tubs that had remained out of doors were found next morning filled with muddy and very dirty water." A letter we have before us, says:—"Since the 7th of December it had been raining at intervals of half an hour. On the 12th, tubs were found in the morning filled with black water, remainings of the rain we had last night. There are persons who assert that it has rained until eight this morning, and that the same rain stained the clothes that happened to have been left out of doors to dry. There is no doubt that on the 12th December, 1862, it rained *black water*. The people of the district were very much alarmed, and the female portion began to pray fervently."

A Vegetable Anomaly.—M. Alphonse de Candolle observes:—"*Quercus chrysolepsis*, *lutescens*, and *virens*, of the centre of the United States and of Mexico, are forms closely allied to the *Ilex;* but the *Q. virens*, whose fruit I have been able to examine, presented the singular character of having only one cotyledonous mass, instead of the two cotyledons of the Ilex. A profound difference may thus be masked under an uniform aspect."—*Archives des Sciences*, No. 60, p. 349.

Formation of Striped Muscular Fibre.—Mr. J. Lockhart Clarke, F.R.S., writing in the *Quarterly Journal of Microscopic Science*, observes that in man the development of striped muscular fibre is on the same plan as in birds and mammals, but with certain points of difference. In the early stage the striking forms do not appear which are seen in the chick between the sixth and seventh days of

incubation, and in the sheep or ox at a corresponding period. From the fourth to the fifth week of utero-gestation is about the earliest period at which this tissue can be distinguished with certainty from some others. In a fœtus of three-quarters of an inch in length, it forms a gelatinous mass, consisting, as in the other cases described, of fibres and nuclei imbedded in a semi-fluid granular blastema. In the formation of these fibres granular processes of condensed blastema extend from the sides or from around the nuclei, and along the surface of these a new substance forms, until they become partially or completely invested." Mr. L. Clarke investigates the assertion that the formative bodies of striated fibre are true "nucleated cells," and remarks, "I think I may safely assert that in man, mammalia, and birds, the granular substance surrounding the nuclei, and concerned in the development of the muscular fibres, have no envelope or cell-wall in the proper sense of the word, and that these bodies are not entitled to be considered as nucleated cells." He adds, "however, there is little doubt that the muscular substance is the result of some process carried on by the nuclei themselves."

Reproduction of Æquorea vitrina.—Dr. Strethill Wright states in the *Quarterly Journal of Microscopic Science* that he received two live specimens of the above medusæ in November, one about three inches in diameter, and the other about six and a-half. "The number of lips of the latter was about forty, the radiating canals, each having a long double ovisac, about eighty, and the marginal tentacles, by estimation, four hundred." On examining the ovaries he found the eggs hatched, and the young, in the form of almost invisible planulæ, were issuing from the ovisacs. Some thousands were gently extracted with a glass syringe, and placed in tanks of clean sea-water. In three weeks about a score had developed into campanularian polyps, and about a hundred were progressing to that end, the rest having disappeared. The little planule fixed itself to the glass, secreted a "scleroderm," and put forth a polyp bud, which swelled day by day, and at last opened and displayed twelve attenuated tentacles, "joined together for about one-third of their length by a web, the polyp inclosed in a cell terminating in many acuminated segments." Dr. Wright considers the hydroid phase of Æquorea vitrina identical with that of Laomedea acuminata in shape, but so excessively small as to be invisible to the naked eye. He adds that the medusoids increase in the number of their elements, lips, tentacles, etc., as they grow, and he observes, "the question as to the larval state of Æquorea vitrina is settled. This, the largest of all the naked-eyed medusas is the reproductive phase of one of the smallest of all the hydroidæ."

Pycnogons in Polyps.*—Dr. Strethill Wright, alluding to Professor Allman's discovery of the occurrence of pycnogon larvæ in certain vesicles of the Coryne eximia, and to similar observations of Mr. Hodge, with reference to hydractinia, states he has observed pycnogons in the latter zoophyte. Some of "the polyps appeared bloated and overgrown under the use of their pycnogon diet" when examined by Mr. Hodge; and Dr. Wright found a similar polyp, which contained three larvæ of a pale yellow colour, which seemed destitute of legs. As the development of the pycnogons proceeded, the polyp tentacles were absorbed, and the polyp became a long sac, pointed at its upper extremity, and fitting closely on the larvæ. He agrees with Mr. Hodge in imagining that the larvæ of the pycnogons are swallowed when very young by the polyps of the Coryne, and carried through the tubes of the cœnosarc until they arrive at a part which is about to become a polyp, which thereupon has its destination altered; but as the cœnosarcal tubes of the hydractinia are too small to admit of this process, "the pycnogon sacs in this zoophyte are formed, not by the arrest or change in development of an immature polyp, but by the degeneration of a tentacled polyp previously perfect." —*Quarterly Journal of Microscopic Science.*

Force of Waves.—*Cosmos*, speaking of the January storms, praises the admirable system of warning organized in England by Admiral Fitzroy, and then

* Pycnogons are small, odd-looking, eight-legged crustaceans common on our coasts.

proceeds to mention some instances of the force exerted by the waves during the prevalence of the unusual wind. Blocks of stone weighing thirteen tons were hurled to a distance of more than thirty feet, and blocks of three tons to more than one hundred yards. The outer harbour of Fécamp was destroyed, and the mass of earth torn from the north side of Cape la Hève was estimated at more than 300,000 square yards.

Spectra of Stars.—M. Secchi reports that by adjusting the pocket spectroscope of M. Jansen to his great equatorial at Rome, he obtained brilliant and beautiful results with many of the stars. The colours varied in different stars, as did the disposition and number of the dark lines. M. Jansen will publish a complete account of these investigations, but in the meantime M. Secchi states that α Orionis affords a very remarkable spectrum with numerous and notable interruptions.

Action of Sulphuric Acid on Lead.—Messrs. Calvert and Johnson state that sulphuric acid attacks pure lead more quickly than the same metal in an impure state—a result quite contrary to expectation.

Shooting-Stars and the Weather.—M. Heis, who has devoted much attention to shooting-stars, observes in *Cosmos* that the more the subject is studied the less cause there appears for imagining that these phenomena afford indications of coming weather.

Adhesion of Diatoms and Glass.—Mr. Gray has sent us a glass disk used for covering microscopic objects, to which specimens of Pleurosigma angulatum adhere so firmly that no friction with leather or silk will remove them. The diatoms were deposited from a drop of distilled water, and the adhesion does not arise from the action of any cement, but is apparently a case of the close contact of clean surfaces with strong mutual attraction. Some other diatoms behave in the same way.

Baker's Microscope Lamp.—Mr. Baker, the optician, has introduced a cheap and handy microscope lamp. It consists of a small, well-made, paraffin lamp of glass, attached by a spring clip to the arm of an upright stand, capable of adjustment to the height required. It is furnished with a shade, and being more carefully constructed than the common sort, it appears free from their defect, the escape of the paraffin through capillary attraction.

Variable Star Astronomy.—Notwithstanding the great advances made in this branch within the last few years, it may be said to be still almost in its infancy, and in it a rich and abundant harvest may be reaped by every diligent and careful labourer with the smallest telescope available for astronomical purposes. With the view at once of stimulating and aiding inquiry in this direction, it is proposed to form an association for the systematic observation of variable stars. The observations will be made, reduced, and discussed on a uniform plan, and as in their nature they present no peculiar difficulty, and require no special instrumental appliances, it is hoped that none will be deterred from joining the association through distrust of their own skill, or on account of any supposed deficiency in telescopic power. All who feel interested in the proposal are requested to forward their names and addresses to Joseph Baxendell, Esq., F.R.A.S., 108, Stocks Street, Manchester, or to George Knott, Esq., F.R.A.S., Woodcroft, Cuckfield, Sussex, when steps will at once be taken to prepare and furnish to the members a full account of the methods to be employed, and every endeavour will be made to remove any difficulties which may present themselves in practice.

Equipoise Telescope Stand.—Messrs. J. Parkes and Son, of Birmingham, having furnished us with a telescope stand bearing the above designation, we are able to speak confidently of its merits. Its great characteristic is a high degree of

steadiness when the deepest powers of a portable instrument are employed. The teleseope is suspended by its centre of gravity, so that a slight friction on its axis renders it stationary. The head of the stand is of bronzed iron with fittings of brass, and has a movement by whieh its upper portion can be thrown forward, so as to permit the observation of zenith stars. The folding legs, of polished oak, are bound together by three metallic arms, whieh meet in a central plate that reeeives the lowest portion of an upright brass rod, the upper part of whieh is fixed to the head of the stand. This rod gives a firm support to an excellent vertieal rackwork, and the head of the stand is furnished with a smooth and effieient horizontal motion, put in aetion by a handle with an universal joint. The appearanee is handsome, and the weight not greater than is desirable to prevent vibration.

Gauss Telescope Glasses.—An article by M. Radau in the *Annuaire du Cosmos* for 1862, called our attention to the success obtained by Steinheil, of Munich, in constructing teleseope objeet-glasses, on the prineiple embodied in the formula of the celebrated mathematieian, Gauss. It was stated that an objeetive of the new kind possessed all the advantages which Gauss antieipated, and was free from the faults of his original conception. One of three inehes aperture, "the radius of whose eurvature was only doubled by that of the aperture," and 46 inehes focal length, sustained a magnifying power of 300 and more, and was affirmed to be superior to any Fraucnhofer of the same dimensions. MM. Peters, Listing, and Klinkerfues, were cited as authorities for its merits. The latter had been able to obtain an indication of the duplicity of γ Leonis (distance 2·7″) with only 40, and resolved it completely with powers of 60 and 100. The same teleseope "also permitted him to see the feeble campanion of β Orionis, as well as a Merz of 49 lines aperture." These statements induced us to apply to Dr. Steinheil, who kindly fitted one of the new 3-ineh glasses to a telescope sent him for the purpose. In his catalogue these glasses are rated one-third higher in value than the Frauenhofer pattern, and it is stated that they have "sueh a mode of setting, that the distanee, inclination, and position of the lenses to the optieal axis, may be adjusted so as to produee the best effect." They are, in faet, mounted so as to be eommanded by six serews, three aeting vertieally, and three horizontally. Our glass arrived several months ago, with the adjustment disturbed by the journey, and it is possible we have not re-arranged it as perfeetly as Dr. Steinheil would have done, nevertheless it possesses remarkable merits. It shows the little Pole-star with 45, when the sky is so light, that, as repeated experiment has shown, ordinary persons could read large print. Castor appears as two minute but distinet dises, with the same power, and in favourable moments a thin dark line of separation appears: γ Leonis is an easy objeet with about 100, and Sirius when in full blaze is redueed to a clean planetary disc. A power of 300 separates γ Leonis widely, and shows the eolours beautifully, and about midnight on the 11th February, when the air was steady, though somewhat misty, the same high power worked admirably on Saturn, showing the brown belts and the very slight openings visible in the ring. We found in these last cases a better effeet was produeed by the aplanatie eyepieee of Horne and Thornthwaite than by one of the Huyghenian pattern. The state of the weather has preeluded our ascertaining the limits of the power of this glass, as, for some time past, good performanee upon any objeet has only been possible on lueky, and often very fleeting oeeasions. On some of these we sueeeeded in dividing ζ Orionis.

77th Asteroid, diseovered in November 1862, by C. H. F. Peters, Hamilton College, U.S., in size like 12 mag. star.

J. W. Wood. del

THE INTELLECTUAL OBSERVER.

APRIL, 1863.

THE NEW BRITISH SNAKE (CORONELLA LÆVIS), SMALL CROWNED SMOOTH SNAKE.

BY A. D. BARTLETT,

Superintendent Zoological Gardens, Regent's Park.

(*With a Coloured Plate.*)

A MINUTE description of the size and colour of this snake would fail to distinguish it from the viper, as both these species vary greatly in size and colour. The markings, the general appearance, and form and size of the head are the best characters to attend to; in general appearance it much more closely resembles the viper than the common ringed snake (*Natrix torquata*), but may at once be known from the viper by the imperfect **V** on the top of the head, and instead of a single dark zig-zag line down the centre of the back, as in the viper, there are two rows of dark spots down the back; the head is also much shorter, smaller, and rounder than the head of the viper.

It was on the morning of the 24th of August, 1862, I saw, for the first time, one of these animals, Mr. Fenton having stopped me as I was driving along the road in the Regent's Park, and, taking from his pocket what I then thought was a viper, asked me if I would accept it for the Zoological Gardens. I confess I felt in fear of its bite, until Mr. Fenton held it in his hand, and allowed it to bite his finger several times. I then examined its mouth, and saw that its teeth were like the teeth of the harmless snakes, the poison fangs not being present. Having perfectly satisfied myself upon this point, I handled it, but could not help observing that this snake was much more fierce than any common snake; it bit me several times, but without any injury to the skin, in consequence of the shortness of its teeth. Mr. Fenton's opinion of the origin of this snake was at that time stated to me; he said he believed it to be a

hybrid between a *viper* and a *common snake*. This led me to call the attention of Dr. Gunther, Mr. Buckland, and others, to the subject, which soon proved our new animal to be a well-known continental species, and Mr. Buckland at once set to work to learn all that was known, or could be ascertained, respecting its occurrence in England. The result of Mr. Buckland's energetic action has brought to light no less than fourteen individuals of this animal that may fairly be considered British specimens. And, doubtless, many more will follow, now that the subject has been brought to notice. It is by no means surprising that this snake has so long passed unnoticed, considering its near resemblance to the viper, and considering also how few persons are inclined closely to examine such creatures.

To say that serpents, large and small, have at all times, and in all countries, been regarded with fear, is not sufficient to account for the almost universal dislike and abhorrence in which they are held. The true cause of this instinctive dread doubtless arises from the real danger that attends the too near approach to these animals, many of them being provided with the most deadly of poisons. And the knowledge required to distinguish these from those which are harmless, will at all times prevent their becoming commonly or universally understood. To distinguish the poisonous species from the innoxious is not so easy a matter as sometimes stated, and considerable danger attends examinations to determine to which they belong; the poisonous snakes of Australia fully bear out this point, as their external form and general appearance would indicate that they belong to the snakes that are without poison. In the early-recorded history of our species, the serpent is held up as the symbol of evil; in the hands of the cunning and skilful they become powerful agents to deceive, and impose upon the credulous. Snake-charming, as it is called, is still practised in many countries, and it is quite impossible to remove the superstition that exists in the minds of many intelligent persons upon this subject; the artful and crafty manner in which these designing persons have studied the habits and nature of these animals almost exceeds belief. The opportunities I have had of testing the power of some of them (the so-called snake-charmers), convince me that they do not dare handle a freshly-caught cobra, or other poisonous serpent, except in their own peculiar way, and they fear the poisonous bite as much as other people. The rapid action of the poison, in many cases, must satisfy any one who may have the opportunity or desire to investigate the subject, of the danger attending the experiments. It frequently happens that an animal, struck and wounded by the poisonous fangs of a

serpent, say, a *puff adder, cobra,* or *rattlesnake,* will die in six or seven seconds; with a knowledge of this power, it cannot be a matter of surprise that these animals are regarded with feelings of horror and disgust; the dread of death from such a cause would call forth a natural repugnance towards the whole race: the larger ones are feared on account of their great strength and power; the smaller, from the danger of their poison fangs. Again, the habits of these creatures are not likely to decrease our fear. Many of the most deadly lie concealed just below the surface of the sand, ready to strike a death-blow to the incautious traveller; others lurk and hide in the branches of trees and bushes, from which they dart upon the unwary. The wonderful resemblance in colour they bear to the places in which they are found, render them difficult to be seen by the unpractised eye. Many species are aquatic, and among these there is reason to believe many are highly poisonous. This point has been warmly disputed, but doubtless the best authorities assert such to be the case. The power of fascination attributed to these creatures appears quite unfounded; having for many years paid considerable attention to this subject, and having almost unequalled opportunities of forming a correct opinion, I have arrived at this conclusion, not hastily, but with, I trust, a fair and impartial consideration.

FLOWER SPOTS OF THE DESERT.*

BY WILLIAM BOLLAERT, F.R.G.S.

For weeks, ay for months, had the young people of Iquique, Huantajaya, and Santa Rosa been on the look-out for the misty clouds of winter, settling over the lomas or summits of the

* Names of some of the plants found on the Lomas of Iquique. Latitude 21° S. Examined by Mr. Miers :—

Cleome chilensis, var. pubescens.	Dolia vermiculata.
Talinum.	Tetersena amœna.
Bryonia convolvulifolia.	Sisyrinchium ?
Argylia Feuillei (Begonia radiata).	Leucocoryne ixiodes.
Gilia ?	Notholœna remota.
Convolvulus.	Usnea.
Verbena.	Oxalis.
Lycium fragosum.	Peperomia.
Nolana atriplicifolia.	Chenopodiacea.

Some of the plants found on the Lomas about Lima in latitude 12° S. Examined by Raymondi :—

Ismene Amacæs, the beautiful bulbous Amancay.	Bomarea ovata.
Begonia geraniifolia.	Oxalis.
Quamoclit coccinea.	Solanum.
Valeriana off. and pinnata.	Commelina fasciculata.
	Piper crystallinum, etc.

mountains of the coast, and which were to be sprinkled soon afterwards with pretty flowers and curious plants.

What is the cause of this bounteous effect of Nature's hand? It is not easy to understand or explain it.

During the day of the long and hot months of summer in these latitudes, southerly winds, inclining to the east, blow along and rather off shore, so that the diurnal evaporation from the surface of the South Pacific is blown seaward and away from the land. At night the wind gets more easterly, forming a land breeze; this is but of short duration, and it is probable that the sandy coast has been left too hot from the sun's heat of the day to allow of any moisture being deposited from these limited land-breezes, even if there were any moisture of consequence in them.

Then the great S.E. trade winds, after they have left the South Atlantic charged with vapour, have deposited what was held in solution in the shape of rain in Brazil, and, ere they arrive in the frozen region of the Andes, have been deprived of the greater portion of moisture, the small remainder being left in the upper portions of the Andes and Cordilleras. I was surprised to see so little glacier and snow when at heights in the Cordillera of South Peru from 15,000 to over 17,000 feet, and could only explain it by this view—that there was so little moisture for the winds to deposit. The winds coming from the eastward must become bone-dry in traversing nearly the whole of the longitude of this portion of Peru, and from the two prime facts, namely, that the southerly winds blow off the land, and the easterly are destitute of moisture, originate the deserts of Peru.

However, during the short winter months light winds come from N.N.W. and N.W.; these being somewhat charged with vapour yielded by the Pacific Ocean, and the land not so heated as in summer, deposit dews and cause mists, to which many names are given, as *cerason*, *camanchaca*, and *garua*; the last may be called a very slight drizzle, which is only observed on the mountains of the coast at certain elevations in the various latitudes.

With what joy this season used to be, and is still hailed, even by the charming and fastidious Limeñas. A writer in the *Mercurio Pernano* (I. 30, 1791) says, "About the period of St. John commences the *paseos* or rambles to the ravines of the Amancaes (blue, yellow, and white bulbous plants); these rambles end the latter part of September. At this same period are the *paseos* also to the *lomas* (summits of the hills). The soft *garua* of that time of the year nourishes the land, and produces pretty little flowers. The diversions here are of a sweet and rural character, they delight and cheer the inhabitants of this desert

portion of the country, leaving no ill consequences, even should they over-feast or over-dance themselves, or sleep on the sand with a bright moon staring on them." Ulloa tells us that these *lomas* are clothed with verdure, and enamelled with flowers of the most radiant colours, to the great joy of the people, who, as soon as the severity of the winter has abated, resort to these flower-capped hills, which exhibit so elegant an appearance. Then if it causes so much pleasure to the dwellers of beautiful Lima, where every luxury can be obtained, we will essay to give an idea of the annual *paseo* to the *lomas* in the Tiempo de Flores in South Peru.

Let us suppose that at last it has been arranged that the young folks of Iquique shall go by Molle to the faldas (steep sides) and lomas of the Morro de Tarapaca, then to enjoy hospitality at the mines of Santa Rosa and Huantajaya, and then onwards to the lomas above Iquique.

We are astonished to find how many young girls and young men can congregate for the trip from out of the few families resident at Iquique, including the amiable Don M. B., who it was well known would enliven the party on its route by recounting a good stock of amusing stories; there was also a very prince of Yaravi (Indian melody) singers, Don M. F., and lastly Don Jorge and myself.

For days previously, preparations had been going on as regarded the "provend" in the shape of bread, cakes, chickens, fish, hard-boiled eggs, and sweetmeats; not forgetting the drinkables, including the favourite French liqueur, "Parfait Amour," for the ladies. All these things are stowed away in *alforjas*, or saddle-bags, not being unmindful that each also contained a gourd full of water.

All are stirring at early dawn, for we are going to have a long day of it. The donkeys get an extra feed of maize and an extra drink of water; they are duly caparisoned with the comfortable saddles and pretty bridles, the manufacture of Arequipa; scarlet and blue *pellones* cover the saddles, bound on by a party-coloured *sincha*, or girth.

The sun-burnt beauties sally from their rude habitations, all joy and excitement, with their Panamá hats, ponchos, bright scarlet, orange, or blue pollera or petticoat, and their naturally small feet, made to go into still smaller shoes of spruce make and of all colours.

One of the señoritas was rather older than the rest, and had to look a little after the younger ones, and instead of the light and rather long pollera, she had on the somewhat antiquated "Faldellin," a very short crinoline, worn as a dress. However the bewitching *Saya y Manta*, a curiously close-fitting garment, was in use, the upper portion being narrow,

and made to hide the head and face, excepting the eyes. This has since faded away, and now the frightful European bonnet and dense dresses are worn.

Well, it was a pretty sight to observe the cavalcade (donkeyade) start. Nimbly did we trip over the earthquake-elevated, shelly plain of Iquique, with the huge granite and porphyritic mountains to the left, the placid Pacific to the right, its waves rolling gently on the sandy shore, and the sea-air purity itself. The animals had rather a hard pull through a deep sandy track at the base of perhaps one of the highest *medanos* in the world, literally a mountain of sand, which we christened "La Ballena," or the "whale," from its resemblance to that monster of the deep when out of the water. Subsequently, a friend of ours, a Frenchman, attempted to explore this colossal heap of sand on mule-back, from opposite to where we were travelling, when having got midway up with great difficulty, he and animal began to sink in the sand. In a moment he threw himself out of the saddle, and the reins over the head of the mule. Keeping hold of the end of the rein, he did his best to roll downwards, tugging at the mule; now he sank in the loose sand almost out of sight, then the mule was well nigh submerged. It was terrible—a fierce, but at last a successful struggle for life.

We arrive at the elevated shelly plain above Molle; here are a number of Tumuli, the graves, most probably, of a coast race of Indians called Changos. Subsequently I opened some of these ancient tombs, and found the desiccated bodies, wrapped in coloured woollen and cotton mantles, in a sitting posture, with pottery, wooden combs, bones, pointed, used as awls, spines of the cactus, pierced at the end for needles, copper fish-hooks, stone arrow-heads, brown and red mineral pigments, and heads of maize. In one was the mummy of a dog; in another that of a bird.

We now descended to the ruins of the silver amalgamating works at Molle, said to be so called from a mullu or mastic tree once growing at the foot of the high and escarped porphyritic mountains. If a tree ever grew there, the climate must have been different from the present, yielding some water by rain, or there must have been filtration of comparatively fresh water from the interior, no signs of such a state of things now existing.

Here we make our first *pascana* or halting-place, and whilst a fire was lit to prepare chocolate, I wandered about the rocky and sandy shore. In clear, deep pools were myriads of *erisos* or sea-eggs, of various sorts, shells, and enormous quantities of sea-weed. On the rocks there were numberless bright-eyed and inquisitive-looking lizards, two or three species of them,

and so tame in their wild state as almost to let me catch them. But what a stillness ! The morning had now become perfectly calm, with not a ripple on the waters; not a vessel in sight. I was hidden among the dark rocks, and could scarcely believe I was so near to a merry party bent on pleasure, until I heard a shout, "Almuerzo"—breakfast. I returned to the ruins, and already was Don M. tinkling his guitar and singing a favourite ditty of those times.

Our meal is soon over. "Al camino" is the word. We tighten up the saddle girths preparatory to the ascent of the celebrated Morro, or Mountain of Tarapacá, the summit of which is about 6000 feet above the level of the sea.

On the shore we fell in with a solitary family of Changos; these are the aboriginal Indian fishermen of the coasts, and are probably a remnant of one of the ancient tribes of Atacama. They neither speak Aymará or Spanish, and are nearly in as miserable a condition as the savages of Tierra del Fuego. They roam about the coast from south of the valley of Copiapo, in Chili, to hereabouts, transporting themselves on their floats of seal-skin. We gave them some tobacco, for which they blessed us.

We began to "faldear," or creep slantingdicularly up the long base of the Morro, and when about 2000 feet above the level of the sea, came upon a little pasture—a thin, dryish grass, each stem an inch or so apart, at which our donkeys began to nibble, and some of them may not have had such a treat for years. Continuing upwards, we beheld an interesting sight in a hollow (where there was some grass), namely, a pure Indian family reposing there, whilst their donkeys were browsing in the desert pastures. Here were the three generations, the grandparents, parents, and grandchildren, on their way from the interior to the coast, to collect guano to manure their little farms. These were pure Aymará Indians, descendants from that stock, who may have built the Pre-Incarial masses of masonry of Tia-Huanacu, who were subdued by the Incas, and became worshippers of the sun according to Incarial formula; and they wore black garments, said to be in memory of the murder of their Incas by the Spaniards, and their still degraded position. One of the young Indian girls was really pretty, nicely dressed in flowing robes, with her necklaces, silver tupus, or spoons with pointed ends, serving as pins to keep her dress together, and her party-coloured faja or sash. We christened her at once "The Flower of the Desert," but her real name was "Quespi," or the "Bright one."

Bidding adieu to these children of the sun, who remained quietly *acullicando*, or chewing their beloved coca, our ascent began to be steep, over sand and sharp stones, often obliging us

to dismount, which made rather a toil of pleasure. At last we struck some huanaco tracks, made by these animals when browsing, which assisted us in our climb. From the fresh footprints we observed, we anticipated a sight of these fleet-running animals; and on reaching an undulating plain about two-thirds up the Morro, sure enough we saw a small troop of them. But our object was not to have a huanaco hunt, and we were without our guns or dogs.

It was now past mid-day, the sun's rays told on us; there was no breath to be wasted in singing, or even chattering. The señoritas of the party would exclaim, "Ay que calor" (Oh! how hot it is). "Quando llegaremos a la Pascana" (When shall we get to our resting-place?); "Deme un poco de agua por el amor de Dios" (Give me a little water, for the love of God).

"Here we are," shouted one of the party, who was acting as *vaqueano* or guide. Our resting-place was in the shade of some huge broken rocks, looking as if they had been tumbled down from the peaks above us by earthquakes, and shivered in their descent. What a desolate scene it was! that mountain ravine we were in, running, as it were, across the Morro of Tarapacá.

Having come to a halt, we unsaddled the donkeys, giving them the length of their halters, so that they might nibble at the slight pasture. Our first refreshment was the *ulpo*, made of ground maize, baked with sugar and a little cinnamon in powder, mixed with water. A cigar followed, and we rested full length on the soft sand.

Now came the cry for the *fiambres*, or the cold provisions, produced out of the saddle-bags. This was our dinner; after which, our Apollo, Don M., tuned his guitar for one of his best songs. The song being ended, and the sun somewhat lower, and the air freshened with a breeze, we "saddled up," continuing our journey.

For some time we traversed the mountain plain; on our right rose the remaining portion of the Morro and its peaks, the whole a scene of the most utter desolation. We now came to a very steep incline without a track, so steep that we had to dismount, dragging the animals after us. Here we would often slip downwards, half imbedded in portions of dislodging paniso or disintegrated rock; indeed, at times we were in some danger of rolling down, or of loose stuff and broken rock falling upon us. Had either occurred, it might have been fatal.

Every one promised never to take this "short cut" again, but go round by the Indian track. Some thirty years afterwards, however, I accompanied Dr. B. to explore this Morro for mineral matters. We were on horseback, and got into a similar

or rather worse position; with very great struggling I succeeded in making the descent, but my companion had to leave his horse and get to Molle on foot. Next morning the horse was rescued from some precipices on which it had managed to get.

Having arrived at better travelling ground, although much broken, where some rocks of an argillaceous limestone presented themselves, together with large patches of nodular common salt, we came to a rest, and stretched ourselves on the ground for a few minutes; and after a short halt continued our way.

I must here digress a moment to speak of the mines of El Carmen, which were discovered in 1778, about the same time as those of Santa Rosa; at the latter we were going to pass the night. The veins at El Carmen were found rich at the surface with native chlorides and sulphurets of silver; they were worked without any care or order, and when the pits were only moderately deep they were abandoned. But they are not worked out, the veins are only picked into here and there, and under other circumstances of management, and a cheaper rate of labour, this spot, as well as Santa Rosa, Huantajaya, and some other localities, will still yield abundance of treasure. I may here observe that at Huantajaya, in particular, the "desmontes," or rubbish of the mines, outside and inside of them, is in very large quantities, and could this be economically taken by tram or railroad, say to Iquique, and worked there, it would lead to a new and profitable branch of business. According to some recent assays of the Huantajaya "desmontes," it is said that they yielded about 40 ounces of silver per ton; picked heaps gave about 71 ounces per ton. However, my opinion is that the cajon of 6400 lbs., yielding 80 ounces of silver, is nearer the mark = 28 ounces the ton. In 1861 a railway was projected from Iquique to the interior, to the nitrate of soda quarries; should this be realized then there would be no great difficulty in transporting these "desmontes" to the coast, and there working them for the silver they contain.

A question was asked as to the cause of the mines of El Carmen being abandoned. The answer was, it was said that a white mule had been foaled there, which circumstance caused the mines to discontinue yielding!

We were now on the Santa Rosa knot of mountains, wending our way in "Indian file," or one behind the other, through deep desert ravines, the ridges of the mountains forming them towering from 1000 to 2000 feet above us. Then we wound along the shelving sides of mountains, at times covered with huge masses of rocks. It was on one of these mountains I first became acquainted with the "Pintados," or colossal sculptures, in their slopes. The "Pintados" are made by scraping away a portion

of the loose *débris* of the mountain in such a way as to form a variety of figures of Indians, pumas, huanacos, suns, moons, circles, squares, etc.; and in one such locality a tomb was discovered, containing the body of a female completely desiccated, dressed in penguins' skins; at its side was a bow and a quiver full of arrows. The custom of forming these "Pintados" must be a very ancient one, for the present Indians say they know nothing about them, save that they must have been made by the "Pagan Indians," before the arrival of the Spaniards.

As we approached Santa Rosa, we heard the church bells ringing and small rockets cracking, and in a few minutes afterwards a number of our acquaintances came out to welcome our arrival, escorting us into the town. I say town. Reader, imagine the long slope of a desert mountain, the loose stuff on the surface irregularly broken out, the masses of which piled up, form, if possible, more irregular habitations. Some of this stuff contained so much common salt, that in time, by the help of slight and occasional dews, it had become agglutinated together, forming the walls, which were merely covered with matting. There was no arrangement of streets whatever; here a house, there the mouth of a mine, and heaps of "desmonte" everywhere. There were, however, some half dozen habitations built of boards brought from Chili, the dwellers of which looked upon themselves as somebodies, and at that period their mines were in "boya," or giving abundance of rich ores.

One family took charge of some of our party, another took others, so in a short time we were disposed of for the night; and after such a day's tramp, we slept soundly upon the *estrada*, or a part of the floor at the end of the apartment, raised like a broad step; for, as yet, bedsteads or many other articles of comparative civilization had not been introduced into that portion of South America.

The next morning we were shown over the place, and entered some of the mines. When first discovered they commenced their yield in native and chloride of silver. One mine produced much sulphuret, another very large quantities of sulphurets of silver and copper. I entered one, the "Paniso," which was then in "boya;" it had given since 1815 to 1826, £600,000. Another mine, the "Arcos," had just given a little "boya" of three yards long and twenty in height, valued at £20,000. They had been, and were working these mines in the most miserable manner, and the proprietors were told that if they continued their honey-comb and rule-of-thumb system, instead of by shaft and adit, the yield of the mines would soon be brought to a stand-still, which proved to be the case.

In 1853-4, the writer paid another visit to Santa Rosa, to look at the place, as one goes to see an old friend. The houses

of wood were gone, the other habitations were in ruins, the church had tumbled down or had been overthrown by an earthquake, and not a soul was to be seen. At last, while prowling about, the mew of a cat was heard, and then the starved pussy was seen perched on a ruined wall; then the sound of the blows of the comba, or miner's hammer, was heard to come from the mouth of the once famous "Paniso" mine. A stone was rolled down the mine, which is one way of announcing oneself at the mouth of a pit, and two brothers (miners) made their appearance. They were merely doing a little experimental work, and the vein was giving a small portion of native silver; this, to them, was not a favourable sign; they would rather have been working in a poorer ore, for the chances then might have led them to abundance of it. The writer asked why the mines had not been properly worked. The answer was, that since the nitrate of soda quarries had been opened, the labouring population went to them; then the continual revolutions took the young men away to the army, and the President Castilla (a native of the province) seemed to require more soldiers than any of the previous "mandones," or rulers.

I will not pause to describe the ball and other festivities by which the evening of my first visit was passed; but on the following morning early, the whole party were again on their way, resting for awhile at the celebrated mines of Huantajaya, to the mountain-range of the coast, to the loved "lomas" of the flower spots in the desert.

As we were all connected with mines, we made a *détour* to "catear," or examine the country mineralogically. But with so joyous a party little was done, save a general admiration of the "Lindos Panisos," or beautiful indications of metallic matters. These Panisos are caused by the heads of the veins protruding to the surface, the copper, iron, and other metallic substances oxidising, and giving their colours to the desert mountains.

Onwards we go, mainly along the slopes of the hills, these and their bases often covered with salt, sand, and angular pieces of rock, some of the latter looking as if they had lain there undisturbed for ages, and that the fierce heat of the sun had half burnt them up.

At last we arrive at the upper base of the coast mountains (the lower base being below on the shores of the Pacific). We are about 2000 feet above the sea, and some of the summits are 1500 feet above us. They are of granite with porphyries reposing thereon.

Diminutive pasturage is fallen in with, then a small plant or two with green leaves, and in a short time we enter a dell in which this desert vegetation is seen to increase, and then come

to a spot where there is a pretty abundant crop of blue and white flowers, called azucenas or lilies; so we named the dell the "valley of the lilies."

In accounting for the flower spots of the desert, the elements we have to deal with are:—1. Mountains from 2000 to 3000 feet above the level of the Pacific Ocean, and hereabouts formed of a very feldspathic granite. It is easily decomposed on account of the rather large quantity of soluble alkali in the feldspar, and thus a loose surface is produced. Seeds of plants can be brought here by the easterly winds from the interior, which blow generally at night, or conveyed in the ordure which the huanacos and vicuñas deposit in these localities. In close proximity with the granite a mighty formation of porphyry reposes. On the latter rock, as a rule, there is no vegetation, it being less prone to decomposition, and not affording holding ground to seed or plant. From the decomposed granite we have, however, obtained soil which is without a trace of humus; we have brought the germs of vegetable life hither, we will now look for their nourishment.

2. During the greater portion of the year the winds blow along, but somewhat off, the coast from the south, so that all moisture in the air formed by the sun's heat from the waters of the Pacific is blown off the land to the west, to be deposited again in another portion of the same sea. Did these winds blow on the shores of this land, the moisture held in solution in them would be deposited as heavy dews and rain, and tropical forests would appear, where now there is but a sandy and saline desert.

3. The short months of winter succeed, and then N.W. and N.N.W. winds blow on the land. The sun now being north of the equator, the atmosphere is cooler, cloudy days and misty nights occur, and in the height of this desert winter, the *garua*, or very slight drizzle, is occasionally deposited on the summits, in the dells and slopes of these mountains. These *garuas* do not extend any distance inland, for in this latitude, just past this mountain boundary, no vegetation is seen, until the base of the Andes is reached, and there it is scarce. The Cordilleras are barren; on descending to the table-lands, 12,000 to 13,000 feet above the sea, the vegetation is stunted and peculiar; but when the mighty masses of the Andes are passed, you come down upon magnificent tropical flora, extending, in some places, across the continent to the coast of Brazil.

4. The great S.E. trade winds have left the greater portion of their moisture in Brazil, and ere they reach the Andes have but very little to deposit on their peaks, after which they blow to the N.W., bone-dry, maintaining nearly the whole of the west coast of Peru in absolute sterility, excepting where a scanty stream

may find its way down the narrow valleys from the Cordilleras to the west.

It is the *garua*, or thick winter mist of the coast, that nourishes the seeds transported to the flower spots. First in the progress of organic life is a spare pasture; upon this a few wild huanaco and vicuña feed, having migrated from the Cordilleras. A stray fox may sometimes be met with, but what this animal finds to eat I cannot tell. The condor is seen to whirl about majestically, and a little slate-coloured bird may be heard to chirrup at times.

Whilst exploring, I came upon some of the party who had got into a growth of the small blue and white lilies. They were in great glee, and I could hear them joyfully exclaim, as I was botanically occupied, "Look, how pretty these flowers are; how beautiful, see, see! Why not remain here for ever, build a house, and always have a garden?" Yes, these periodical and stunted flower spots in the desert seemed then to my friends ever-blooming glades, and sylvan groves.

I collected specimens of the pasture, lilies, and oxalis; in all about twenty different species of plants, one of which, I think, must have been a Solanum, or member of the potato family,* and there was one plant I tried to persuade myself was a shrub. I came upon two or three species of small cacti, and then fell in with what I took for the gigantic cactus, with a yellow flower. Some of these were thirty to forty feet high, the girth at the base being ten to fifteen feet. I think it is the same species I have seen in abundance on the lower portions of the Cordilleras, where it is so tough as to be cut into narrow planks. These cacti are in comparative abundance, and on some occasions have been used as fuel at Iquique. I found the bright green leaf of one plant rolled up in such a manner as to enable it to hold a portion of water. This was handy, I thought, for the little slate-coloured birds to drink.

I found on the cacti the following Bulimi, named, I believe, by Mr. Cumming: Succinea Broderipii, Bulimus virgulatus, B. erosus, and at their roots little heaps of their dead shells. Laden with specimens of the plants, bulimi, and pieces of rock, I returned to our camp, where an excellent repast was set out, including a good salad made from the Vinagrillo, or Oxalis Acetosella. Here we remained for some time discussing our repast in this mountain solitude.

Of the flowers which had been collected, some were made into bouquets, others placed round our hats; even the headgear of the donkeys came in for a share of floral ornamentation.

We now commenced our journey back to Iquique, bidding adieu to the Valley of the Lilies. We ascended to the pass of

* This collection I have presented to the Linnean Society.

Guantaca, from whence we had a glorious view of the Pacific and its iron-bound shores. Rapidly descending the mountain range, at times our animals had to slide down through the deep sandy track; arriving at the bottom, we trotted briskly over the plain to Iquique, which we reached whilst the vesper bell was ringing for the "Oracion," when all good Roman Catholics kneel to say the evening prayer.

We were now a goodly party, but got them all fairly accommodated. For some days afterwards our mountain friends enjoyed sea-bathing, fishing, paddling about on balsas, trips to the island, formerly covered with guano, and hunting for shells.

At this juncture a good friend to the poorer people of the whole coasts, Captain Bowers, came into the bay with his ship, the "Catalina." He did not require any pressing to give a dinner and dance on board his vessel, which was heartily enjoyed by all.

A few days afterwards our Santa Rosa and Huantajaya friends returned to their mountain homes, the abodes of the silver-fabricating gnomes of Tarapacá.

OBSERVATION OF BOLIDES.

BY ALEXANDER S. HERSCHEL, B.A.

The description of a large meteor's passage through the air has been a narrative homely and familiar to all since the ingenuity of man first combined the elements of earth and air and fire, to direct the flight of rockets and to please the eye with the gay discharges and the flashes and explosions of fireballs. Yet the spectacle is grand and awful when we revolve the real wonders of the sight. If it is seen by day, no bird is so high, no balloon, nor even a cloud; mountains and valleys are undistinguishable to this visitor as it swiftly approaches the dangerous circle of our globe. If seen at night moving beneath the stars, it is nearer to those than the whole height of our dull but lofty atmosphere!

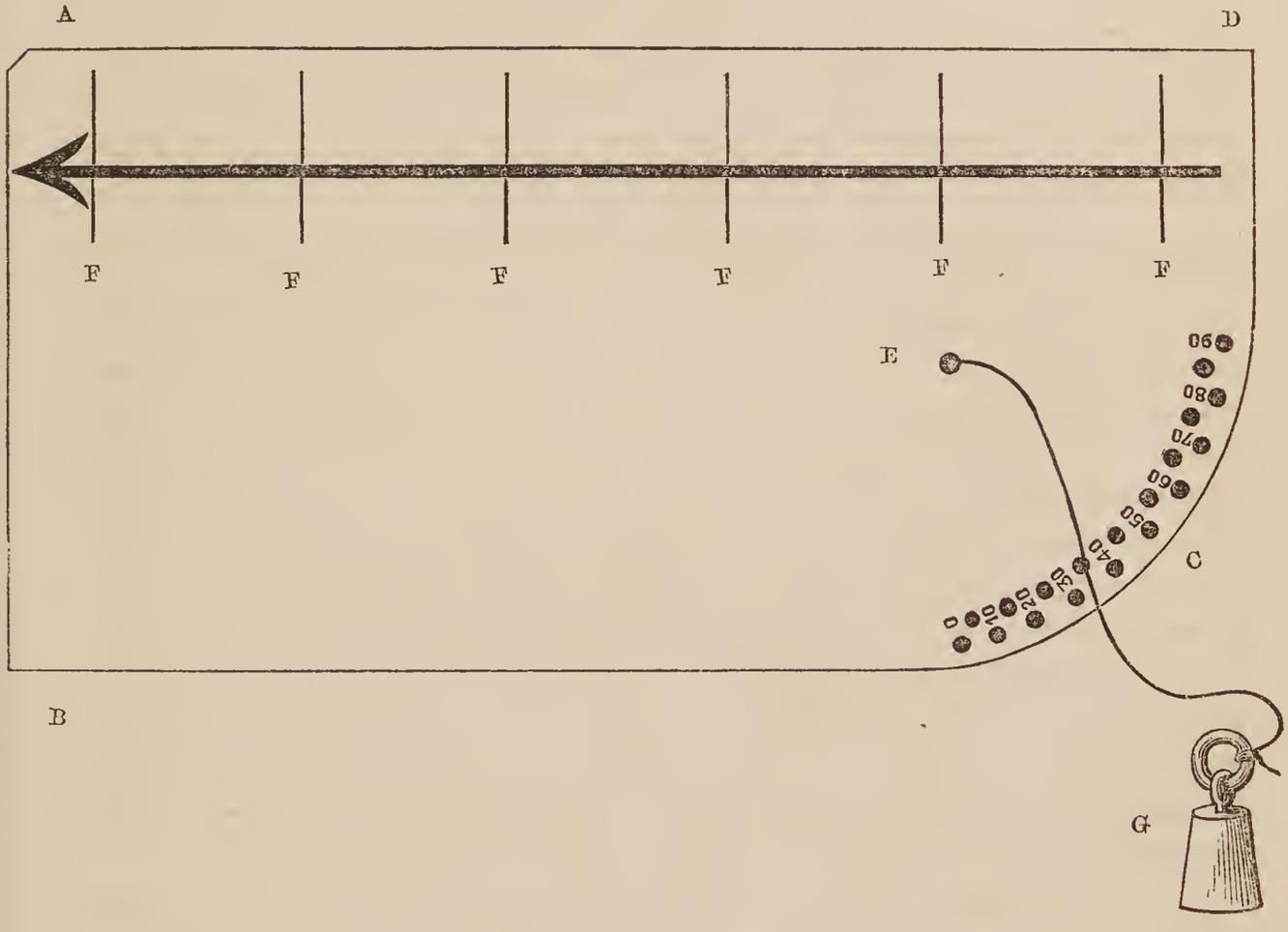
Suppose it to be a small shooting-star only that is seen. Its distance and its trajectory are as great as those of a meteor. Philosophers are not yet agreed upon the true nature of these apparitions, but it appears not improbable that the shooting-star is an exceedingly small paring of metallic iron, or a grain of sand, piercing at twenty to thirty miles a second, the extreme fluid coverings of the earth. The brightest meteor, it is equally probable, may be no larger than a schoolboy's marble, or a

hazelnut or walnut! Such a fragment may yet suffice, with great velocity, to strike the air with rolling thunder, just as the slender thong of a whiplash may be made, with velocity enough, to produce an astonishing report. As the floating fibres of the whipcord mark the spot at which the lash was drawn with detonation through the air, so these unearthly projectiles leave luminous clouds of unknown nature floating on the course to mark their track, and in the cause of this remarkable phosphorescence is undoubtedly to be sought the origin of the vivid light that the slender fragments are able to elicit from the air. By the blow of their intrusion through different regions of density, aided by the disruptive, liquefying, and calcining actions of the heat which probably accompanies the light, their slight substance is crushed and scattered or exhausted, the velocity, quickly yielding to resistance, is destroyed, and their subsequent descent to the earth in a few extremely small fragments is no longer matter of perception. Some larger bodies, however, occasionally encounter the earth's globe, and, piercing the fluid envelopes, penetrate, with unexhausted velocity, to the ground; but their occurrence is singular and rare. Such aerolites, or aerosiderites, as they are called (masses of stone or iron fallen from the air), are preserved in considerable numbers in our national museums, where they form collections yearly increasing in interest and extent. The stones possess a great resemblance or likeness of character among themselves. Scattered through the fragment of a greyish-looking sandstone are seen glittering particles, like filings, of metallic iron alloyed with nickel, bright particles of iron pyrites, or iron combined with sulphur, and particles of olivin, a yellow, gem-like crystal, or of felspar, the crystalline component of granite. Frequently oolitic or seed-like grains of all of these mixed substances together abound throughout the structure. The fragment is entirely clothed with a thin, black, polished or enamelled crust. The last is the same glass or slag to which the mineral is fused before the blowpipe, and on certain specimens it may be seen raised in wave-like lines, as if rippled in the molten condition by the force of a powerful wind. When on any side the crust is wanting, the fracture has, in some remarkable instances, been exactly covered by the similarly exposed faces of smaller stones, fallen at the same time many miles from the place of the principal descent. These accumulated fragments of the several falls give from a few pounds to many hundred weight, as the weight of foreign matter occasionally descending to the earth. The aerosiderites are of much greater weight, but of various sizes, little altered by their passage through the air. Like rude settings of valuable gems, the clear crystals of olivin are seen bedded in their sponge-like cavities. The metal contains invariably a portion of nickel in

alloy, and its fibres are found by section and etching to have a constant crystalline structure. The character of these minerals, and the circumstances of their arrival, places their extra-telluric origin apparently beyond a doubt. Professor Quetelet has, however, most recently doubted the existence of an unbroken analogy between these bodies and the smallest shooting-stars. Such an analogy can only be traced in the fugitive or ephemeral features of their apparition, and simultaneous observations at distant places of one and the same fugitive flight are indispensable to the study; but of the rarer aerolitic falls no precise observations of the kind are found; shooting-stars, and the associated class of bolides (fireballs or large meteors) and detonating meteors, have alone yielded trustworthy results to observation. The periodic recurrence of the first, in showers, renders the tribe of shooting-stars an old subject for concerted observation, and bolides no less would seem to appear in groups, but not expectedly. Unless it be that the brilliance of a single individual elicits by discussion the notices of others no less brilliant than itself, instances may be cited to show that the recurrence of this phenomenon twice upon the same evening is more probable than that a brilliant meteor should appear alone and singly in a day. Until a physical connection can be pointed out by reason of which a group of shooting-stars should have one, or the least, dimension in common, such a group of bolides a second dimension in common, and lastly by which the aerolites, perhaps too far apart to show themselves in groups, occupy a series of superior dimensions, three classes of phenomena apparently distinct present no hypothesis whereby they may be collected under a single head. Some recommendations which follow for the observation of large meteors, may possess points of interest for those who are not habitual gazers upon the heavenly vault.

When a large meteor attracts the gaze of a fortunate beholder, let him attend some minutes for the occurrence of a report. Throughout the flight of the meteor he may compare in numbers *the length of the head with its width*, and certain peculiarities of figure, light, and colour common to meteors will correctly impress themselves upon him as they arise, and afford ground for future remarks. Immediately on the meteor's disappearance the points of appearance and disappearance of its course should be compared with surrounding objects. All objects, whether the angles and roofs of houses or the boughs of trees, should be pressed into this service, to avoid the uncertainty which quickly arises when the light has disappeared. On a starlight night, if the constellations can be recognized, no better course can be pursued than to align or triangulate the points of apparition and extinction with the best-known neighbouring constellations; but, in default of these, the places of appearance

and disappearance should be marked with deliberation by surrounding objects, and a visit to the spot may be made at some future time for measurement. Sentences, numerals, or the alphabet should be repeated in estimation of the meteor's duration or of the interval elapsed to the occurrence of a report. The first of these estimations, leading to a knowledge of the meteor's velocity, is of especial value to the theory of their origin.* To measure from landmarks the course of the flight, there should be cut from stiff cardboard an altitude card (six inches by three) of the following pattern :—



A B C D is an oblong card, twice as long as broad, one corner of which is cut away by the quadrant C of a circle, about the centre E, graduated with a protractor to ninety degrees of arc from the transverse to the longitudinal direction of the card, as shown by the figure. A plummet line, with small weight attached (as shown at G), is fastened at the centre, and hangs freely over the face of the graduations while the card is in use. A series of transverse incisions F F F . . . divide the back of the card into ribs, which admit the point of a straight rod or cane inserted between them to the whole length of the card in the direction of the arrow. This instrument has every

* The alphabet may be repeated distinctly fifteen times in a minute, and in small intervals of time the sixth part of a second becomes by its aid a quantity sufficiently easy to observe.

accuracy sufficient for the intended purpose, but if greater precision is desired, a wider card with longer incisions may conveniently be fastened upon the tube of a small hand telescope, and an observation of the horizon employed to secure the proper adjustment of the arrow-line to the axis of the telescope. Reaching the spot where the observation was made and marked, the observer will direct his pointer to the spot previously determined, where the meteor finally disappeared, the card and plummet vertically downwards, depending from the rod, until the plummet is at rest. Slightly twisting the rod towards the right, the plummet will be held fast by its own weight upon the edge of the card, until the card can be lowered, examined, and the *altitude* read off. The rod and card are now held at arm's length between the observer and the sky, the card and plummet depending as before vertically downwards from the point of the rod, between the observer and the place of disappearance of the meteor, but the handle of the rod directed onwards in the imaginary prolonged line of the meteor's apparent flight towards the horizon. The rod is thus directed, by the eye recovering the meteor's course from the landmarks of the previous evening; and being followed downwards to its intersection with the horizon, this point of intersection is marked by known objects of the view. Its *bearing* is to be afterwards found by compass, or by reference to an ordnance map of the locality. The card and plummet depending from the rod between the observer's eye and the place of the meteor's disappearance inform the observer at the same time of the *slope* downwards from horizontal at which the meteor passed from view. The card should again be tilted, by slightly turning the rod before the rod is lowered, to examine the card and read off the *slope of path.* A fourth observation, of the *altitude of the place of apparition,* completes the set of these observations, and suffices (with general remarks to prevent misapprehension) to render the description as accurate and valuable as any that can be expected at the present day to be obtained.

THE FEET OF ARACHNIDÆ.

BY L. LANE CLARKE.

(*With a Tinted Plate.*)

The feet of Arachnidæ are more varied than those of the Diptera, the family is larger, the individuals more gifted in every way, of higher organization, and with an instinct that raises them in position to a near kindred with the upper circles of creation.

In examining the feet, we cannot help going beyond the external form to question why such admirable tools are given to what, at first sight, is an ungainly and troublesome "creeping thing."

We will begin with the foot of the common house-spider (fig. 1), which requires to be well mounted in balsam, and a good half-inch lens to see it properly; then, indeed, we perceive the two claws, toothed like a comb, with from eight to fourteen teeth, and a third simple claw, acting like a thumb to the sensitive small hand, which twists, and spins, and weaves, and builds nests for its young and snares for its food.

If we now take another foot, that of the beautiful garden-spider, the *Epeira diadema*, we shall see, beside the two large toothed claws, five others, also toothed, branch forward from the heel of the foot, and must assist it greatly in the formation of its geometric web and pretty cocoon, slung under a green rose-leaf in a hammock of the softest silk (fig. 2). Unlike the fly, the spider has no pulvillus, and, therefore, if able to run up a wall, it is by the action of these sharp and toothed claws on the inequalities of its surface; also by the length of its legs, and in some species by the number of joints in its tarsi, giving such pliability that the feet are capable of every variety of inflexion, sometimes even of a spiral one, whilst, from their span and equal hold of eight equidistant spaces, the body is balanced and supported in every position. The species I refer to are the harvest-men, *Phalangium*, whose tarsi have upwards of forty joints, and resemble antennæ.

A house-spider seems to be incapable of walking upon glass, unless it throws up an invisible ladder of its own making, touching the glass here and there with its spinnarets, and giving its hind feet a resting-place, when it speedily escapes from a tumbler. The experiment is best made with *Clubiona atrox* in a champagne glass; but it happens sometimes that the spider will approve of its prison, and weave for observation both a snare and a den, and a little honey or treacle on the edge of

the glass will attract its prey, and the action of this tiny foot may be closely observed.

I have spoken of the spider's foot as "a sensitive small hand," and certainly the pulmonary spiders, or aristocrats of the tribe, possess a nervous organization which lead us to believe in very acute senses.

They have no antennæ or known organs of hearing, yet they are sensitive to sound, and even capable of pleasure in the vibrations which cause our own nerves to thrill under the harmonies of music. Several examples are upon record; but Michelet gives one that is less known, in the spider-friend of little Berthome, who was a musical prodigy, in the year 1800. The poor child, stimulated into unnatural development, was confined for many hours a-day to practise in solitude. The music attracted a house-spider (*Tegenaria domestica*), which at first left its web, and stationed itself on the music-stand, then crept daily on the child's arm, and as long as the music was heard, the spider rested there; when it ceased, it retreated to its web.

This continued for many months; at last a visitor, with the unloving heart of ignorance, seeing the little creature on the boy's music, struck it to death; the child fainted—was ill of grief for three months, for he had recognized in that small living thing a fellow-sufferer and a friend.

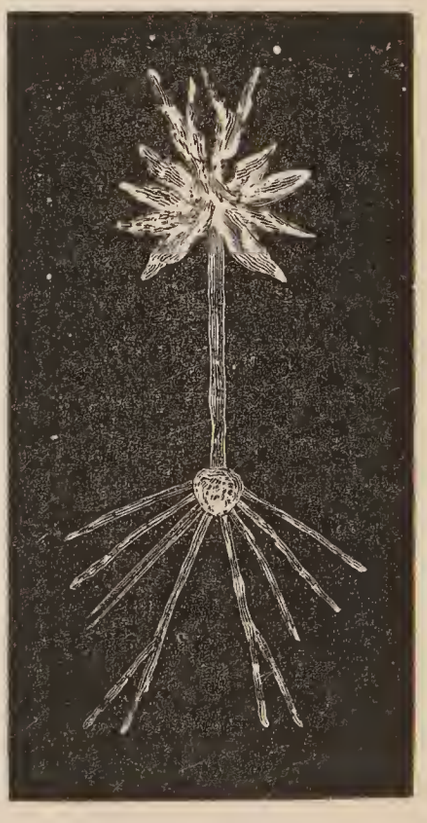
Besides the sense of hearing, do not the eyes of spiders follow with marvellous exactness the movements of their prey? The *Salticus*, tiger-like, springs with unerring certainty upon the restless fly, creeping, and sidling, and whirling round instantaneously for the fatal leap.

Does not this little foot *feel* delicately for the silken line, and test its strength before it trusts its body to a fall? Does it not coil up a floating filament, and join two broken cords? or, more wonderful still, carry in its toothed claws that cable of *six thousand strands* from corner to corner of the angled wall, with care avoiding contact, lest it stick in a wrong place? When a spider has dropped from the ceiling, how does it ascend again so quickly? The spinnarets do not suck in again the twisted line; no, the hinder feet, using the simple claw as a thumb, rolls up the thread into a ball, and holds it ready for further use, or throws it away if not needed. The same handy foot has been observed clearing the web of an *Epeira* when flakes of falling soot had sullied it, gathering the dirty and broken threads, rolling them into little pellets, and flinging them to some distance, and still the busy feet tapped and tried every mesh of the snare, never breaking any, but replacing a missing link with geometric precision, and in such positions that by *feeling* alone could this have been accomplished, as the work was out of sight of the spider's eyes.

Feet of Arachnidæ.

Can any one look at the nest of the *Mygale* or trap-door spider, without wishing to see the tools with which it was made? What could have enabled it to dig into solid argillaceous clay, impregnated with oxide of iron, six or seven inches deep, line it with a beautiful orange-coloured tapestry, and furnish a door so curiously, that it is the perfection of insect architecture? The door of this nest, though but three lines in thickness, has thirty layers of finest web, and a hinge so perfect, that it may be opened hundreds of times without injuring the spring; moreover, it has been measured for a living bolt that shall secure its inmate from outward violence — small holes are made, where the claw of this foot shall hook, and bar the spider's fortress and her home. I doubt not that in the work of all the Mygales the powerful foot-jaws or mandibles assist considerably, the short stout spines upon these claws being better adapted for hard work than the delicate combs of Epeira (fig. 3, foot; fig. 4, mandibles).

I might cite innumerable examples of the handiness of a spider's foot, but its *sensitiveness* leads us from the external crust to consider the cause of all its *sentient* power. The spiders of which I speak are remarkable for the concentration of the nervous mass or ganglia in the cephalo-thorax. There is a nearer approach to the brain of the vertebrate animal than in any of the insect tribe, and from that firm compact stellate ganglion, strong nerves pass into the thrilling legs. No wonder, then, that a spider, more than any creature, except man, feels change of weather, and measures its gossamer line by the current of electric fluid. Never does the little *Aranea* or *Clubiona* spin a long line in wet and windy weather. The *Epeira*, if beginning a new web, shortens the main lines considerably in doubtful weather.



It is this nervous susceptibility which is exercised by the little *Segestria*, a small spider which lurks in the crannies of our garden walls. Crouched in its silken tube, out of sight and power of seeing, it stretches out six of these feet, each holding a thread that communicates with the snare, and verifies the poet's words:—

> "The spider's touch, how exquisitely fine,
> Feels at each thread, and lives along the line."

The heedless fly, the wandering gnat, scarcely touch these

lines without a spring and a fatal nip from the jaws of the concealed enemy.

Thus much for the pulmonary spiders; but the lower ranks of this large family, though greatly beneath them in organization and instinct, have yet, many of them, very pretty feet, worthy of our observation and a place in our microscopic cabinet.

(Fig. 5.) The foot of the common cheese mite (*Acarus domesticus*) has a single hook surrounded by a membrane called a *caruncle*, capable of inflation and retraction, for it is a double and purse-like organ, called by the Germans bursten or purse, and is analogous to the pulvillus of a fly.

(Figs. 9, 10.) The foot of *Xodes* or dog tick, an acarus which, for its curious rostrum, as well as for this appendage, should be carefully examined and mounted.

(Fig. 7.) The foot of *Uropoda vegetans*, a parasitic acarus, often found on coleopterous insects, attached to them by an anal peduncle, through which it derives its nourishment from the juices of the beetle.

(Figs. 6, 12). The tarsi of the pretty little water-mites, *Limnochares* and *Hydrachna*, ciliated for swimming, and armed with tiny hooks for clinging to water-plants and to the Nepa, upon whose body the Hydrachna lays its eggs.

(Fig. 8.) The tarsi of *Dermanyssus*, pest of our canary cages.

(Fig. 13.) The beautiful caruncle of *Gamasus coleoptorum*, the common parasite of the dung-beetle, which is said to indicate the early or late harvest, according as they cluster towards the thorax or the anus of the poor beetle they infest.

(Fig. 14.) Foot of *Pachygnatus*, a small mite found under stones in damp places.

(Fig. 11.) The examination of feet of *Trombidium* and others of this numerous family will amply reward the patient observer.

VARIATIONS IN PLUMAGE.

BY W. B. TEGETMEIER.

Some years since, when conversing with one of the most eminent of living zoologists, I expressed an opinion that naturalists had overlooked many sources of information in neglecting the variations that were capable of being produced in our domesticated animals. The facts that extreme changes in form and colour can be produced almost at the will of the experimenter, and that dogs, pigeons, fowls, etc., can almost be bred to pattern, show that there are certain laws regulating the production of varieties which, being facts, cannot be otherwise than important.

The reply of the *savant* was very characteristic, and, as coming from one of the most profound systematic naturalists of the day, was the more emphatic:—"Do you know the reason," he replied, "why naturalists have neglected varieties and the laws which govern their production? It is simply because they do not know anything about them."

This reply confirmed me in the course I was then pursuing, and I continued, as far as was compatible with other engagements, the study of the changes capable of being produced by artificial selection.

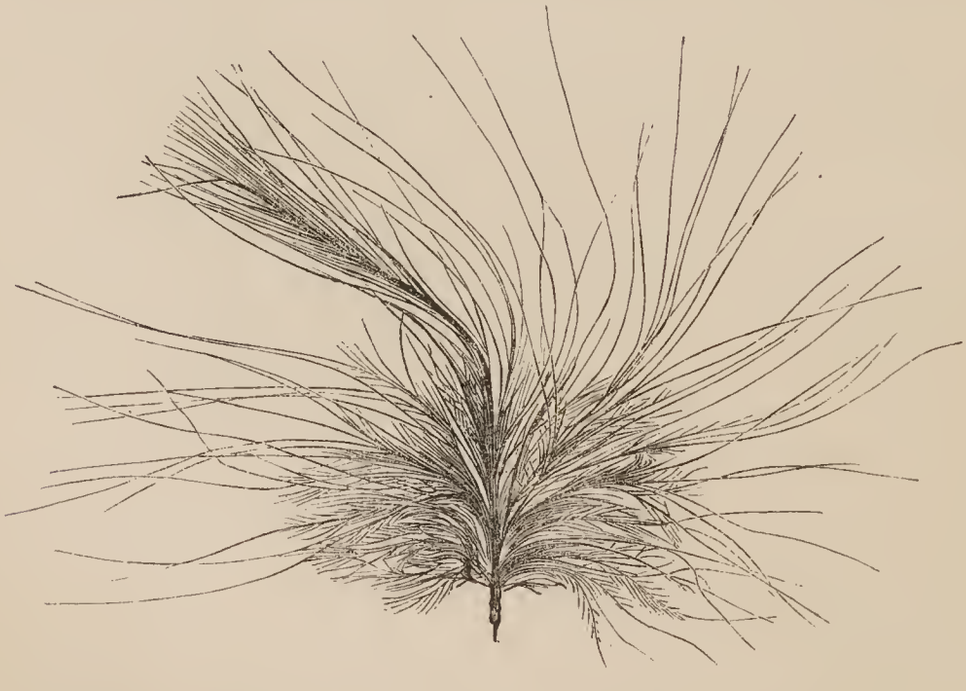
At the present time it cannot be said that varieties have not received a considerable share of attention. Their production by artificial selection bears so strongly on the hypothesis which ascribes the origin of species to natural selection, that they have risen rapidly in the estimation of all scientific men, and this appreciation has extended even to those who, like myself, have endeavoured to trace out their origin, to study their structure, and to ascertain the limits to their variability. But a few years since, my special pursuit—the variation of poultry and pigeons—would have been regarded as rendering me a fit companion for Spitalfields' pigeon-fanciers and Nottingham cock-fighters. At the present time I find that the observations I have made on these subjects have obtained for me the acquaintance and friendship of some of the most eminent scientific men of the age. One of the most remarkable of these variations occurring in the plumage of birds, I propose describing in this communication.

In the January number of the Intellectual Observer there appeared a notice of some fowls with black periosteum and skin; and I may state that under the title of "Coq à Duvet" (Gallus Lanatus), Temminck, in his *Histoire Naturelle des Pigeons et des Gallinacés*, has described those birds which are now known at our poultry shows under the title of *Silk*

fowls. These birds, of which I possess several specimens, are brought from many parts of eastern Asia and the Indian Archipelago. They are small in size, and are remarkable as having the skin and periosteum of a dark bluish-black. Their flesh, however, is perfectly white, and, as Temminck states, surpasses that of other poultry in its flavour. The plumage of these birds is most remarkable for its downy character. Every feather, even the large primaries and secondaries of the wings, has the barbs entirely disunited, giving rise to that silky appearance from which the fowl derives its English and French trivial names.

I have found that when these birds are mated with other varieties, the mongrel offspring are characterized by the dark skin and periosteum, but that the plumage takes the ordinary colour and character; and it is not perhaps until the fowl is killed for the table that its dark and repugnant-looking skin is noticed. Moreover, there is but little doubt that it is this mongrel so reared that Temminck describes under the title of *Coq Negre* or *Gallus Morio*.

In all the wild species of gallinaceous fowls there exists no example of this strange peculiarity of feather. The question to be solved at once presents itself, What is the origin of this peculiar breed? Whilst the subject of variation was regarded with the contemptuous ignorance to which I have before alluded, I do not think that any answer could have been given to the question. But at present some light can be thrown on the



FEATHER OF COCHIN CHINA HEN,—EXAMPLE OF VARIATION.

subject. I have now in my possession a Cochin hen in which the entire plumage of the body is broken up into a covering of a texture closely resembling in appearance the character of the fur of a rough tortoiseshell cat or fawn-coloured rabbit.

This peculiarity arises from the barbs of the feathers remaining perfectly distinct, the barbules being straight instead of curving and hooking into each other, as is usually the case. Some of these feathers have been very beautifully photographed by Mr. C. Walker, of Norwood, by means of the carbon process; the photographs being printed directly from the feathers without the employment of a camera. One of these has been carefully engraved, so that the exact structure of these singular feathers may be seen. From this specimen the peculiar appearance of the bird may be inferred. The fine filaments at the top of the feathers form the external layer of the covering, and produce the extraordinary hair-like appearance that is so very remarkable in the entire plumage. It is obvious that a bird so clothed can have not the slightest power of flight, being in this respect reduced to the condition of an Ostrich or an Apteryx.

Now, as to the origin of this singular animal: Some years since a single bird thus peculiarly clothed was hatched from an ordinary pair of Chinese fowls, the cause which determined the variation being, as is usually the case, utterly unknown. By hatching the eggs of this hen, and by a careful and long-continued selection of those offspring which showed most completely the tendency to develope the peculiarity of the feathers, the breed of silky Cochins was at length established. Here, then, is the production of a permanent and fixed variety by artificial selection.

Now, let us imagine such an occurrence as the production of this variation occurring in a state of nature, it is obvious that a bird of moderate size, destitute of any natural means of defence, and incapable of escape by flight, could scarcely by any possibility avoid being destroyed by its natural carnivorous enemies, hence there would be no possibility of the perpetuation of a small breed of silky fowls in a state of nature.

Nor, with the exception of the Apteryx or Kiwi Kiwi of New Zealand, which is being rapidly exterminated, does there exist any small sized land-bird with a plumage rendering it incapable of flight. On the other hand, many large birds, whose size and strength enable them to protect themselves from their natural foes, possess plumage of a loose and divided character, such are the Ostrich, Emeu, Rhea, and many others.

Those who agree with Mr. Darwin's views on the origin of species by means of natural selection, will see in this singular fact one which bears strongly on the theory they advocate. Unless we admit some such explanation, the existence of many large birds with loose plumage, and the non-existence in a natural condition of any small species so clothed, is rather puzzling, especially when we know that birds as small as pigeons not unfrequently produce this singular variation.

VEGETABLE TEXTILE FIBRES.

BY J. W. M'GAULEY.

The wide-spread distress which at present exists in Lancashire and other places in consequence of the war now unhappily raging in America, having deprived our manufacturers of their usual supply of cotton, it becomes very important that we avail ourselves of every means to prevent a recurrence of the serious inconvenience we now feel. Although the evil seems to have come unexpectedly upon us in all its terrible reality, it has long since been anticipated by those who looked into the future; and precautions have been from time to time suggested, though without much practical result, in consequence of the seeming remoteness of the danger. So long ago as the commencement of the present century, attempts were made to introduce the fibrous substances of India into this country; but they were treated with apathy, as it was then very unlikely that any substitute for those already in use would ever become desirable. Under the most favourable circumstances, it must be considered a position of great peril to depend for a supply of what is indispensable to the very existence of a vast body of our industrial population on a single material, and, what is much worse, almost on a single locality, over which we have not the slightest control. It was no doubt a great triumph of our energy and ingenuity to have created a mighty branch of national industry, under circumstances so unfavourable that not an atom of the material required for it is produced by ourselves, and very little of it by our dependencies. But the magnitude of the achievement is, at the same time, a proof of its danger, since the possibility of our supply being cut off involves the liability of a great commercial and manufacturing enterprise to meet with a sudden and disastrous interruption. It becomes, therefore, deeply interesting to examine how far such an evil may be rendered impossible hereafter, or so improbable, that the fear of it may be disregarded without hazard. This can be effected only by the employment of varied materials, or by obtaining our supplies from such a number of localities, that the derangement of our intercourse with one of them cannot greatly affect our safety, or by the adoption of both precautions.

Our vegetable textile materials have hitherto been confined to a very few species, and in a very great degree to but one. Yet the number with which nature supplies us is very great. The superintendent of the Botanic Garden at Jamaica exhibited at Paris, in 1855, fifty-one species of fibre from dif-

ferent plants, and Jamaica is far from being the locality most remarkable for their production. It is true that, of the numerous fibres which are dispersed abundantly over almost every portion of the globe, comparatively few are capable of taking the place of hemp and flax, and still fewer that of cotton; nevertheless, excellent substitutes for them have already been found. The Calooee, or Rhea fibre, has all the good qualities of hemp, besides being twice as strong. China grass fibre, Neilgherry nettle, etc., may be used instead of flax; and even cotton is capable of being easily imitated by substances which are almost unlimited in capability of supply. The production of "cotton" from hemp and flax has occupied attention since the middle of the last century in various countries, and it has been effected by several processes, both with economy and complete success. When the details are properly managed, the product cannot be distinguished from real cotton; and, as Berthollet remarked, an equally fine material may be obtained from refuse tow and from the finest flax. Cotton may, in the same way, be obtained from fibres which would otherwise be too coarse for the finer textile fabrics. The objection to a certain kind of fibre may be entirely resolvable into certain changes required in the spinning machinery. This is true of much of the cotton produced in India. To place our readers in a position that will enable them to judge of our resources, we shall briefly notice the vegetable textile materials already in extensive use among us, and those which are the most likely to become in any way their substitutes.

The use of vegetable textile fibres ascends to a remote antiquity. Linen was prescribed to be used exclusively in the dress of the Egyptian priests; and, in the Institutes of Menu, written eight hundred years before the Christian era, it is declared that the sacrificial thread of a Brahmin must be of cotton. Textile fibres require both strength and flexibility. Those obtained from vegetables are not confined to any particular species of plant; they are found in endogens and exogens, in herbs, shrubs, and trees; and they may often be had from otherwise worthless weeds, that are produced in the greatest abundance. Although the stems of endogens, or plants which grow on the inside, often contain a large quantity of fibre, the latter is generally obtained from their leaves, which have a parallel venation—thus the fibre of the pine-apple, American aloe, plantains, etc.; but in some of them—for example, the palms—the leaves are too dense for the easy separation of the fibre. The fibres of endogens are generally white, and of different degrees of fineness in the same plant. They are capable of bearing a great strain, but are liable to break at a knot, which is a serious obstacle to their being employed as textile materials, since, in

weaving, it is often necessary to join the threads, a difficulty which may perhaps be overcome by uniting them with a glutinous substance. Nearly all of them are produced on the sea-coast, or in moist climates traversed by navigable rivers, and, therefore, they are easy of access. Some of them will yield a yarn which is suited to the most delicate fabrics. Fibre cannot be obtained from the leaves of exogens, or those plants which grow on the outside, since they have a reticulated venation, which does not allow the mass to be separated; but it is procured from other parts, where the texture is parallel, and usually by stripping off the bark, as with hemp and flax. To remove the fibre from the woody and other matters with which it is associated, the process of "Retting," either with dew, with the water of ponds or streams, or even—as in some northern countries—with snow, is employed. But, while this renders the woody portions easily removable by mechanical means, it injures the colour of the fibre, and, unless effected with great care, diminishes its strength. It is highly objectionable in a sanitary point of view, since the water in which the fibres are steeped becomes poisonous, and evolves the most pernicious effluvia. Many methods have, therefore, been devised to supersede retting, the best of which, not altogether a new one, is the steeping the fibre for a moderate period in water at a certain temperature.

Although fibrous plants are found in almost all parts of the world, some climates are more favourable to them than others. When the production of fibre is the purpose for which they are cultivated, they must not be too much exposed to heat, light, and air, which harden the fibre, and give the plant a tendency to become branched. The nature of the predominating product is affected by the climate and mode of culture: in the tropics hemp produces *Bhang*, a powerfully intoxicating drug known also as haschisch;* in cold and temperate climates scarcely any narcotic, but abundance of excellent fibre. In India, where hemp is reared only for its narcotic, and flax only for its seed, these plants are exposed as much as possible to the action of the air and light; but in Ireland, Russia, etc., they are thickly sown, that, sunlight and air being excluded, they may attain a considerable height, and produce but few branches.

The true hemp (*Cannabis sativa*), which is believed to be a native of the mountainous parts of Northern India, is obtained from a large annual; but there are several fibres to which the name is applied, although they are produced from plants of a very different species; thus the jute hemp, Manilla hemp, brown hemp, pité or pita hemp, sunn hemp, etc. Hemp was

* The effects of this substance have been described in the December and January numbers of the INTELLECTUAL OBSERVER.

placed by Jussieu in the family of the nettles, and along with it the hop plant; the latter also produces a fibre that might be turned to a useful account. Hemp, probably, has not been so long in use as flax, but Herodotus mentions that the Thracians made from its fibre a cloth equal to that of flax in fineness. It grows well, either in the heat of India, the cold of Russia, or the moderate temperature of Italy or England; it flourishes at the level of the sea, and in the Himalayas, six or seven thousand feet above it. But Russia and Russian Poland are the localities where it is chiefly cultivated; and some of the finer kinds are prepared with great care. It is one of the few plants grown in England which are *diœcious*, that is, have male and female flowers on different individuals; only about half the plants therefore produce seed, but the quantity they yield of it is very great. Although the male plant comes the soonest to perfection, both male and female may be pulled together, when the production of fibre, and not seed, is intended. We consume about two thousand tons of hemp annually, of which Russia supplies nearly three-fourths. If not tarred, when worn out as cordage, it answers well for paper, and for oakum: which is not the case with many of the substances that may be used instead of it.

Flax (*Linum usitatissimum*) is a native of Asia, but it was introduced very early into Europe. It has been in use as a textile material from the remotest times. The paintings in the tombs of Egypt, and a microscopic examination of the mummy cloth, afford unquestionable proofs of its early cultivation in that country. It is mentioned in the Pentateuch, and other of the most ancient portions of the Scripture; and Homer alludes to its manufacture. The flax plant belongs to the *Linaceæ*, which contains many species, most of them remarkable for the tenacity of the fibre of their inner bark. As the elements of the dressed fibre are obtained almost wholly from the atmosphere, if flax alone is removed from the land the plant is not an exhausting crop, and the prejudice against it, on this head, is unfounded. Its inorganic elements are instruments in the production of the fibre, and should be returned to the soil. Its qualities, which are dependent partly on the climate, and partly on the mode of cultivation, are so various that it may be used for the coarsest or the most delicate purposes, and its price varies from forty to one hundred and eighty pounds a ton. It may be successfully cultivated in very different climates; but it grows in those which are very hot, chiefly because their winters resemble the summers of more northern countries in temperature. Hence, in India and in Egypt it is sown in autumn and harvested in spring, before the seed is even put into the ground in colder regions. About four hundred thousand tons of it are

produced annually throughout the world. Notwithstanding the great encouragement afforded to the cultivation of flax in Great Britain, it has never been grown by us in quantities sufficient for the supply of home consumption; the flax used in the United Kingdom, independently of the seed, would require half a million of acres to be devoted to it, while in Ireland, where most of what we produce ourselves is raised, not a fourth of that space is given to it. About eighty thousand tons are imported annually, all of which, there is good reason to believe, might be produced at home.

The cultivation of cotton is traced to the remotest times; five centuries before the Christian era it was in common use in India for domestic purposes; but its manufacture was almost unknown in Europe until the last century. Less than two millions of pounds of cotton wool were imported by us in 1697, but in 1795 nearly twenty-seven millions, and in 1857 about one thousand millions, and the quantity continued to increase until our supply from America was suddenly interrupted. Cotton stuffs, of gossamer fineness, were made in India at an early period; and though two thousand five hundred years have rolled away, they continue to be produced there, but only by an almost incredible dexterity, which has descended continually from father to son, no improvement whatever, during that long interval, having been made in the mechanism employed. Cotton is a filamentous down, investing the seeds of a plant called by Linnæus *gossypium,* but belonging to the mallows. It is of many species, the most widely diffused being reducible to the herbaceous, the shrub cotton, and the tree cotton. The cotton of India and the United States is the herbaceous kind; that of the West Indies, Brazil, and partially of Egypt, the shrub cotton. The tree cotton flourishes in a wild state in Borneo and other tropical regions, but as a commercial product it is almost unknown. The herbaceous species is the most useful; shrub cotton becomes coarse as the plant grows old. Most of the kinds used by manufacturers derive ther commercial names from the places to which they owe their origin. "Sea Island cotton" was first cultivated in the small islands which extend along the coast from Savannah to Charleston, it is very long stapled and strong. Its excellence caused it to be introduced on the high lands of Georgia, where it became the "uplands" or "bowed Georgian" cotton. But though it still remained a good article in this locality, it degenerated; since a humid atmosphere and sandy soil are required for superior cotton, and to produce the very best kind, a saline soil and a saline atmosphere. Besides the upland cotton grown in Georgia and South Carolina, there is another of an excellent description termed "New Orleans cotton," which is produced on the banks

of the Mississippi. The finest cotton ever imported into this country was obtained from the island of Tobago, in the latter part of the last century, but its cultivation was relinquished for more lucrative occupations, and has not been resumed.

The inconvenience of depending for the greater part of our supply of cotton on any one country, renders it desirable to consider what amount may be reasonably expected from others, if we take the proper means to instigate them to cultivate it. We are, in reality, independent of the United States, since our Indian possessions would produce at least half of what we require, Italy one-fourth of it, Egypt and Algeria the remainder. All that we want need not be of the very best kind, and we can easily obtain what is necessary for the finer fabrics from several localities which produce an article fully equal to the very best American. The shortness of the staple of the Indian cotton has always been an obstacle to its extended use, but it might be improved in this respect by better modes of culture; even that which is at present produced in India would be far more valuable than it is with proper management; it is injured by dirt and exposure to the weather, and its staple is often broken by bad treatment, as appeared clearly from what was exhibited in 1851, and still more from what was seen at the late Exhibition. When due care is taken with them, the cottons of India are excellent, and the very worst of them might be profitably employed, with a slight modification of the spinning machinery, or by mixing them with the long stapled kinds; what can be done with pure Indian cotton has been clearly shown by the Messrs. Platt. That our supply from India might at once be largely increased, is evident from the fact that she exports to China twice as much as she sends to us. But to obtain from thence all that is possible, both as to quantity and quality, we must go there to purchase instead of waiting for the article to be sent to us, as it is from America; we must enable the cultivator to derive full benefit from his industry, by rendering unnecessary the intervention of those who not only swallow up all his profits, but by their mismanagement cause great injury to what is sent to us.

The quantity of cotton supplied by Egypt may be expected to increase considerably, and its quality is of a high order. Mehemet Ali devoted much of his attention to the cultivation of cotton, and the late enlightened ruler of Egypt was fully conscious of its importance. Herbaceous cotton has been introduced into the country; and a cotton is now produced there, from Sea Island seed, which is inferior only to Sea Island cotton. In 1823, less than six thousand bales were received from Egypt; thirty years later it was nearly one hundred and six thousand; the quantity has since become

greater, and it is capable of further increase. Egypt now consumes all its short stapled cotton at home.

Italy, even at present, is a successful cotton-producing country, and, as was shown at the late Exhibition, it is capable of growing the most excellent kinds. The climate of Algeria is particularly favourable to the production of cotton; it already furnishes a large quantity of excellent quality, and the supply to be obtained from it, under the encouragement it is likely to receive, will become far more considerable. We may procure a large amount even from our own colonies. The British West Indian cotton is of the very best description; the finest kinds might be grown extensively in Port Natal; and to any amount in Australia. But, however numerous the sources of supply, if they are liable to be abandoned they will avail us but little, since cotton will not be cultivated for us at such a risk. But it is probable that, before the United States can supply us, as formerly, other countries will be able to compete successfully with them, which has never been the case hitherto.

To remove, as far as possible, all danger from the future, some new materials should, if possible, be adopted, not as substitutes, but as aids to those already in use; and as a means of obtaining these, our possessions in India offer peculiar advantages and an inexhaustible supply. We shall briefly notice a few of those fibres most likely to be useful for this purpose. The plantain and banana tribe (*Musaceæ*) afford abundance of fibre; one of the species (*Musa textilis*) produces the Manilla hemp, which is more beautiful in appearance, cheaper, and more durable than Russian hemp. The cordage made of it is particularly adapted to resist great strains. The plant abounds in the Philippine Islands, and is the Abaca of the natives. Another of the species (*Musa Paradisiaca*) produces a fibre adapted to both coarse and fine fabrics, in very large quantities. Both species afford three layers of fibres of very different qualities.

The nettle tribe (*Urticeæ*), even in these countries, yields a fibre which has been successfully used for thread, cloth, and paper. In the tropics nettles grow to a gigantic size, and many species produce a material exceeded by no other in fineness, and superior to all others in strength. "China grass" is the product of the most remarkable of the family (*Urtica nivea*, or *Bochmeriæ nivea*). It yields three crops in the season; the first affording fibres suited to coarse, and the two last to finer, purposes. But for a minute black spot which it exhibits, it could be applied to the most delicate and costly textile products. It may be obtained abundantly from China. Calooee hemp, or Ramee (*Urtica tenacissima*, Rox.), the Rhea of Assam, which is equally plentiful, is identical with China grass. It is

stronger than the best kinds of hemp and finer than the best kinds of flax, and is beautifully white and silky in appearance. Until recently, it was found difficult to separate the fibre from the woody portions, on account of the presence of a glutinous matter which is acted on by water less easily than the fibre. It will probably rival the better kinds of flax. The plant yields four or five crops a-year, and any quantity of its fibre may be obtained. The "Horoo," "Surat," or "Neilgherry" nettle is the most widely diffused of all the species. It is an annual. The leaves, stem, and branches are armed with bristles from four to eight inches in length, the least of them causing a pain which is very acute, but fortunately of short duration. The bark affords a large quantity of strong, glossy, soft, and silk-like fibre, which is greatly prized in China. It is said to be adapted to flax-spinning machinery; and it gives a warp of great tenacity that dyes as well as flax, and unites admirably with it in cloth. When carefully prepared it may be used for the finest fabrics.

Both the cultivated and wild species of the pine-apple tribe (*Bromeliaceæ*) afford a useful fibre. The leaves of the species so well known for its fruit abound in a fine white fibre, that has been successfully applied to the manufacture of woven fabrics, both coarse and fine.

Some of the palms (*Palmaceæ*), which constitute so remarkable a feature in tropical landscapes, furnish fibres which have been applied to many useful purposes. The cocoa-nut palm (*Cocos nucifera*), which is very abundant in the East Indies, besides its other valuable products, yields "coir," the covering of its nuts. This material is employed chiefly in the manufacture of cordage and coarse woven fabrics, and, from its lightness, elasticity, strength, and durability, it is found to afford the very best kind of cable. The palmetto (*Chamærops humilis*) supplies a fibre which in Sindh and Afghanistan is used for cordage, and in Algeria for paper and pasteboard.

"Jute" is a product of the Linden tribe (*Tiliaceæ*); it is obtained from two of the species (*Corchorus olitorius*, and *Corchorus capsularis*), long used in India as pot-herbs. The fibre, which, in both species, is exactly alike, has been proposed as a substitute for flax, on account of its great length and fineness; but it gradually loses its whiteness, becoming ultimately brown, and its strength is diminished by circumstances which would not affect other kinds of fibre: it is very unfairly used as an adulteration of hemp in the manufacture of sail-cloth. If prepared without "water-retting" its qualities would perhaps be much improved, and it might be rendered fit for purposes that would not subject it to the action of moisture, which is very injurious to it. It is easily cultivated, and is obtained in abun-

dance from the plants. Large quantities of it are consumed in India in the manufacture of *gunny-bags* and other coarse fabrics.

The aloes afford very useful fibres. The great aloe (*Agave Americana*) is a native of America; but it has succeeded so well in Africa, India, and the south of Spain as to seem indigenous to these places. Its fibre, which is of great length and strength, is obtained from the leaves, which are from eight to ten feet in length, and from the roots, which afford what is known as "pita thread." The product of this plant has been found to exceed hemp in strength and durability. Another species (*Agave vivipara*) affords "silk grass fibre," which, until lately, could not be applied to textile purposes on account of the presence of a large quantity of glutinous gum, that can, however, now be removed without difficulty. The true aloe (*Aloe vulgaris*) and the "Adam's needle" (*Yucca gloriosa*), which is sometimes termed an aloe, also yield excellent fibre.

The Liliaceous plants, likewise, produce useful fibres. The Moorva or Sanseviera (*Sanseviera Zeylanica*) is very abundant in Africa, China, etc.; its leaves contain large quantities of a fine white and tenacious material, that is used by the natives for bow-strings.

Sunn, which is obtained from a plant very commonly cultivated in India (*Crotalaria juncea*) makes excellent cordage, sail-cloth, and canvas; but it is inferior to hemp in fineness, strength, and durability. The Egoo or Gomuto yields a remarkable fibre, which is little known in Europe. It is *black*, of great tenacity, and almost imperishable, and is used largely in India for cordage. New Zealand flax, which was discovered by Captain Cook in New Zealand, has been introduced into Ireland and Scotland; it is stronger than hemp or flax, and takes colour as well as either, but, like other white fibres, it breaks at a knot. The *Zostera marina*, one of the sea wracks, has recently occupied much attention; but, like all marine plants, it contains very little solid matter, and the fibre it affords is so small in quantity, compared with the weight of the plant, that were it even possible to procure it in sufficient abundance, it would be little likely to be used as the source of a textile material. It has, however, long since been applied to many important purposes, and the idea of utilizing its fibre is not a new one, since many years ago paper was made of it in Holland.

We have now briefly glanced at the most valuable textile fibres yet known; some of them will, no doubt, from their excellence and abundance, come into very general use. We have not considered the inquiry as bearing very directly on the

manufacture of paper, however desirable it has become to find new materials for it: since it appears certain that whatever is employed for this purpose, to be sufficiently economical, must be previously used for some other.

FORAMINIFERA.

BY T. RYMER JONES, F.R.S.

Few objects are better calculated to illustrate the powers of the binocular microscope than the shells of the Foraminifera; it is hardly therefore a matter of surprise that these beautiful organisms should, at the present time, suddenly have grown into favour, and become, as it were, fashionable subjects for exhibition. From their singular beauty, indeed, many genera belonging to this group of animals richly merit the attention bestowed upon them; the elegance of their forms rivals the symmetry of our most costly vases, the delicacy of their sculpture challenges all the resources of the optician, while in richness of ornament the amphora-shaped encasements of the Polycystinidæ and other kindred families far transcend the tracery exhibited in the most elaborate specimens of Chinese carving. And yet so recent is the discovery of these wonderful productions of nature, and so little is even yet generally known concerning them, that possibly a succinct epitome of the present state of our knowledge in this department of microscopic science may not be unacceptable. However much the imposing size of the larger animals may impress us with a sense of the infinite power of the Creator, however much we may admire the regularity of their forms, the complexity of their organization, or the exquisite perfection of their structure, our wonder is certainly not diminished nor our admiration lessened when we descend to the contemplation of those inconspicuous beings which, by their numbers, make up for the minuteness of their dimensions, and whose infinite hosts perform, unseen by us, one of the most important parts in the economy of nature.

Who, a few years ago, would not have been incredulous if told that on every sea-shore the very sands are half composed of microscopic shells which, in beauty, can compete with those of the Nautilus and the Argonaut, and in the manner of their formation are far more mysterious and incomprehensible? Such, however, are the Foraminifera, the most numerous, if not the most important agents employed in building up the world on which we tread. Six thousand of these exquisitely formed

shells have been counted in a single ounce of sand taken at random from the shores of the Adriatic Sea, and in a similar quantity collected in the Antilles, M. d'Orbigny, the great historiographer of this prolific class of animals, calculated that there were not fewer than 3,800,000 ! The numbers contained in a cubic yard of such sand consequently surpass all intelligible expression—what then must be the Foraminiferous population of the immense extent of maritime coast situated in all parts of the globe ? It may therefore be safely asserted that no other series of beings is comparable to these as regards the numbers in which they exist—not even those minute crustaceans whose myriads sometimes crowd the seas until they give their own colour to the waters ; not even the Infusoria themselves, whose shells compose the polishing slates of commerce, or constitute the *bergmehl* and other rich deposits of animal or of vegetable origin.

If we proceed to notice the special office assigned in creation to these microscopic beings, we shall find not less cause for astonishment. The progressive accumulations of their shells form banks in the sea that become dangerous to the navigator, fill up ports and harbours, obstruct gulfs and straits, and assist, in conjunction with the corals and madrepores, in building up those reefs and islands which are continually making their appearance in the tropical regions of the ocean. The Foraminifera, moreover, constitute the principal organic element brought up by the plumb-line during the recent Atlantic soundings, and are thus proved to be distributed, more or less abundantly, throughout all the deep-sea deposits in all parts of the world. Estimating the importance of their present employment from the testimony afforded by ancient strata, it is easy to prove that these humble organisms materially affect the geological structure of our planet. During the carboniferous epoch, a single species of the genus *Fusulina* has formed in Russia deposits of enormous thickness. The entire mass of the cretaceous system is crowded with their remains. In the tertiary formations they are even still more abundant, witness the nummulitic limestones of which the largest of the Egyptian pyramids is entirely constructed, and which constitute immense beds ranging extensively in Europe, Asia, and Africa. The Foraminifera are likewise met with in countless numbers throughout the tertiary strata of France, Austria and Italy, and nowhere more numerously than in the calcareous deposits of the vast Parisian basin. These latter deposits, indeed, are so densely filled with them, that D'Orbigny estimated a cubic inch of stone taken from the quarries of Gentilly to contain 58,000 of their shells ; it is therefore scarcely an exaggeration to say that the city of Paris, the stones for building which are

principally obtained from those quarries, is almost built with their remains, as are all the towns and villages in that vicinity. Thus we perceive that these tiny creatures, so minute as to be almost imperceptible to unassisted vision, are at the present day modifying the depths of the sea, and during past geological epochs have materially contributed to the formation of the land.

Prior to the year 1835 the Foraminifera were generally regarded by naturalists as being minute forms of Cephalopods, and even D'Orbigny himself, although conversant with the animals in their living state, owing to the imperfection of the microscopes at that time at his disposal, actually countenanced an error which at the present day appears almost ludicrous; and it was to the observations of M. Dujardin, published in the *Annales des Sciences Naturelles* for that year, that science is indebted for the first accurate description of these remarkable organisms.

Their name is derived from the circumstance that over their entire surface they are perforated by numerous apertures or *foramina*, through which delicate filaments are protruded that serve for the purpose of progression, and constitute the so-called pseudopodia of the living animal. The interior of the shell is filled with a glutinous substance, frequently of a tawny hue, the colour of which seems to depend upon the presence of numerous granules of the same tint disseminated through a colourless transparent slime.

To obtain them alive for observation under the microscope it is only necessary carefully to examine portions of sea-weed, to which they attach themselves, or to wash with clear sea-water the surface of stones, corallines, or shells fished up at some little distance from the shore. The washings thus obtained, if set aside in a glass jar, are pretty sure to contain examples of some species, which, after a few hours, will fix themselves to the sides of the glass by means of their ramifying filaments, and may be thus examined with an ordinary lens, or they may be detached and subjected to examination with the higher powers of a compound microscope. Their movements are extremely slow; in fact, when they are upon the march their advance is scarcely more perceptible than that of the hour-hand of a watch. In cold weather, indeed, they will remain quite stationary, only projecting a thread or two of their glairy substance wherewith to attach themselves to the glass; but in summer time, or when the temperature of the room is increased, they evince somewhat greater activity, and the number of their pseudopodia is proportionately increased.

Few things are more wonderful than the movements of these extraordinary prolongations. A filament which, at its first ap-

pearance, is an almost imperceptible thread, simple, and of the same thickness throughout, gradually elongates and expands in all directions, as though in search of some point of support. Sometimes it oscillates from side to side; sometimes it exhibits an undulatory motion, and will then roll itself up into a spiral shape; the turns of the spire next become fused together into a gelatinous ball, from which various prolongations begin to be protruded. As each filament thus elongates, it seems to grow in thickness by the gradual afflux of new material, and emits from either side, at irregular intervals, secondary tendrils, from which, in turn, new filaments are given forth which proceed to ramify in a similar manner. Not unfrequently several branches become connected together by delicate gelatinous membraniform expansions, giving them a palmate appearance like that of a duck's foot, or the gelatinous matter spreads out laterally in irregular shreds and lamellæ.

The retraction of the pseudopodia is effected by movements of a precisely opposite character. The glairy substance, which has somewhat the appearance of melted glass, returns by a sort of afflux towards the central portion of the body, the branches and their anastomoses shrink and vanish in a way that appears truly magical, until they are by degrees completely absorbed into the general mass. The manner in which progression is accomplished by means of this wonderful apparatus is as follows:—When the Rhizopod advances in a given direction the filaments in front are elongated, while those on each side become more or less bent backward, until they relax their hold upon the plane of progression, and are then completely retracted, soon, however, to be replaced by others better adapted by their position to the performance of the intended movements. None of the entire class possess in the slightest degree the faculty of swimming.

Astonished at the varied evolutions of which these extraordinary creatures are capable, and the apparent perfection of their structure, M. Dujardin, naturally enough, proceeded to dissect them, and endeavour to unravel the supposed intricacies of their anatomy; and was not a little surprised, on carefully breaking their delicate shells, to discover in their interior nothing whatever but a homogeneous semi-fluid mucosity, without the slightest trace of muscular fibre, of alimentary canal, or of any of the organs or tissues met with even in the humblest polyps. On proceeding to dissolve the exquisitely-constructed shell by means of an acid largely diluted with weak spirit, the gelatinous substance, freed from its calcareous investment, and slightly hardened by the process, presented itself under the appearance of a series of gelatinous lobules, the shape of which was exactly moulded after that of the different compartments

of the shell, but still entirely made up of the same homogeneous substance. MM. Carter, Williamson, and Schulze, all agree with M. Dujardin as to the complete homogeneity of the semi-fluid contents of all the chambers; and, indeed, the last-named of these gentlemen seems to improve upon the idea, insomuch that Ehrenberg vehemently protests against his describing the body of a living animal in precisely the same words as if it was a fluid. "Determinate organs," says M. Schulze, "cannot possibly exist in an animal all the parts of which are so perfectly identical in value that any particle may, at any time, change places with any other particle." It is certainly difficult to conceive how a creature thus constituted can secrete a fabric so elaborate as one of these polythalanous shells, with its siphons, its partitions, and its numerous foramina, even did the complexity of its structure stop here. MM. Carter and Williamson, and, more recently, the admirable researches of Dr. Carpenter, have shown us that the shells of many genera contain in the thickness of their walls a complicated system of canals, the ramifications of which may be injected with carmine, or displayed by the infiltration of mineral substances deposited during the process of fossilization. "The existence of these wonderful shells," says M. Claparède, "ought to teach us rather to doubt the efficiency of our means of observation, than to refuse to recognize structure in the soft parts of the Foraminifera. Where would have been our knowledge of the microscopic anatomy of the nervous system without the assistance of chromic acid and other analogous reagents? The sarcode of these Rhizopods has not yet found its chromic acid."

The young microscopist will find the examination of these shells a work of considerable difficulty, and one which requires much time and patience. In creatures which, from their minute size, are barely visible to the naked eye, it is only by the assistance of the microscope that the form and arrangement of the chambers, as well as the markings and sculpture of the exterior of the shell, must be determined. It is, therefore, by no means sufficient to treat these shells as ordinary objects by simply laying them on a glass slide, so as to see them only from one or two points of view; they must be carefully examined in every direction, for such is their diversity of form that nothing short of this will be at all satisfactory. For this purpose, they should be attached to the point of a fine needle, so that they may be turned in any direction, and examined by reflected light condensed upon them by means of a lens or side reflector. In many of the thick-shelled species it will be necessary to grind them down on a hone before the number and arrangement of the internal chambers is discernible; and, in order to investigate satisfactorily the minutiæ of their structure, a

variety of sections, made in various ways, is indispensable. These should be examined by transmitted light, after having been immersed in fluid so as to expel the air; they may then be preserved in spirit or glycerine, or, what is better still for the less transparent species, in Canada balsam.

PUMPING SOVEREIGNS AT THE MINT.

The above appears to be a somewhat singular title for a paper, but it is literally true that sovereigns, and indeed all other coins produced at that establishment, are pumped into existence at the Royal Mint. Without entering into a detailed account of the numerous processes and manipulations by means of which ingots of gold are transformed into small circular discs of metal, of the exact size, and standards of weight and of fineness for the reception of impressions, it may be said that those impressions are finally due to the action of the air-pump. Every sovereign, therefore, which has issued from the Mint presses since the erection, in 1810, of steam-machinery for the purpose of coining, has undoubtedly been pumped, as it were, into the channels of circulation. It will be our task presently to explain the way in which the feat is accomplished. The Pneumatic Despatch Company, whose object is the transmission of letters, parcels, and merchandise through partially exhausted subterranean tubes, have simply adopted a modification of the air-pump and cylinder process of stamping money as in use at the Mint. Whether that company will succeed in introducing, on an extended scale, the atmospheric system of letter-carrying, is a problem to be solved. If they do so, the air-pump will stand a fair chance of becoming our general postman, as it is our chief coiner!

Let us, however, proceed to explain the contrivances and means by which the operation of pumping sovereigns is performed at the Tower Hill money manufactory. We will commence with the prime mover. This is a steam-engine of twenty-horse power, on the combined high and low pressure principle, and which was erected in 1846 by the justly-celebrated firm of George and Sir John Rennie. Originally this engine was intended for pumping water, from a deep artesian well on the premises, for the supply of the coining department. It is scarcely necessary to state who it was that in 1851 advised that the engine in question should be made to pump money as well as water, and showed how it could be done. The merit, at all events, of entertaining the proposition and of ordering it to be carried into effect certainly belongs to Captain (now Colonel) Harness, R.E., who was Deputy-Master of the Mint

in the year named. This highly-talented officer gave instructions to the Messrs. Rennie for the construction, under the eye of the inventor, of the necessary apparatus and appliances for the purpose.

An air-pump of considerable dimensions constituted the main feature of the scheme, and this was formed on a perfectly novel plan. It consisted of a cast-iron cylinder, closely resembling in exterior appearance that of an ordinary land steam-engine, but very different in its internal arrangement. The piston of the pump was made up of a series of cast-iron rings, and these were pressed out against the sides of the accurately-bored cylinder by springs of steel. The effect was to make the piston perfectly air-tight, and yet capable of being easily moved upwards and downwards in the cylinder. There were no valves in the piston as there are in those of almost all air-pumps employed in manufacturing processes. The base of the cylinder was a hollow casting of iron, and so was its cover. In these hollow castings the inlet and outlet valves were placed. The upper casting contained sixty-four small apertures, which were covered by small pieces of steel saw-plate, each about two inches long by one inch wide, and fastened by a screw at one end. These delicate springs were in fact the valves. Thirty-two of them were made to open to the atmosphere, and thirty-two to the exhaust or vacuum pipe. The hollow base or bed-plate of the cylinder was furnished in a precisely similar manner. The diameter of the cylinder was three feet six inches, and the length of stroke of the piston three feet. The pump was placed vertically, and immediately below the working-beam of the engine to which the piston-rod was attached.

By this method of construction the air-pump became double-acting, and whether the piston was ascending or descending, it constantly exhausted air from the vacuum tube through the inlet valves, and discharged it through the outlet series. Nothing in the shape of machinery could work more smoothly than did this pump, and this arose mainly from the peculiar character of the valves. The cost of the whole apparatus, with cast-iron exhaust tube, 200 feet in length, ten inches in diameter, and face-jointed, was about £400. This is mentioned for the information more especially of the Pneumatic Despatch Company, who would find the same system of exhaustion—as we think—more effective and less expensive than the centrifugal disc plan which they have adopted at the North-Western Railway station for pumping the mail.

It has been said that the exhaust tube was 200 feet in length. This arose from the fact that the engine-house had been erected at that distance from the stamping presses. Instead of being carried underground, as in the Pneumatic

Despatch system, the tube was in this case carried over the roofs of the coining-rooms, and, descending therefrom, was attached to the great vacuum chamber.

The "vacuum chamber" had existed from the period of the erection of the Mint, and was originally devised by Messrs. Boulton and Watt, the well-known engineers of Soho. They had supplied a steam-engine of ten-horse power, and two single-acting air-pumps, each of which discharged air only in its downward stroke, for exhausting the chamber. This cumbrous and comparatively costly, though for its day very ingenious and valuable arrangement, was set aside when the new air-pump came into use. It had performed its mission, and was henceforth to be reserved as a duplicate in the event of the derangement, by accident or otherwise, of its modern supplanter. A regulating, or relief valve, and a barometer gauge fitted to the vacuum chamber, enabled the attendant to control and adjust the extent of rarefaction within the latter.

It will now be comprehended that, at all times, when the engine and pump are in action, a vacuum of more or less extent must exist in the chamber. The chamber, it may be explained moreover, is a horizontal tube of iron about fifty feet long, and two feet six inches in diameter. It runs along the floor of the Mint pump-room, in a line parallel to that in which the eight coining presses stand. Arranged along the top of the vacuum chamber, and supported by pipes opening into it, are a series of eight cylinders. These are vertical and fitted with pistons, the rods from which are connected by levers and cranks with the presses. The cylinders are open topped, and consequently their pistons are exposed to the pressure of the atmosphere, once a vacuum exists below them. This is the case when the pneumatic valves within the cylinders open to the vacuum chamber. The air within the cylinders then rushes down to the exhausted tube, the atmospheric column drives the pistons after it to the bottom of the cylinders, and the pistons drag with them the central screws of the coining presses. The instant that the beautifully engraved dies are thus made to come into contact with the discs of gold, the latter receive by the force of impact their impressions. The presses then rebound, carrying with them their pistons. The pneumatic valves again open self-actingly, the dies descend upon new blanks supplied to them by mechanical fingers, another batch of sovereigns is pumped into bright and glorious being, and so long as the great air-pump is exhausting the vacuum chamber, and the presses are fed with blanks, so long the series of minor pumps will proceed with their work, and streams of gold, silver, or bronze coins will flow down from the presses into reservoirs placed below to catch them.

THE DISSOCIATION OF WATER.

This term will seem strange to English ears, but perhaps not more so than its equivalent, "*la dissociation de l'eau*" to the French, and at any rate it seems most advisable to preserve the name given by M. H. St. Claire Deville to the very interesting phenomenon described by him to the French Academy, in a paper of which we proceed to give an account.*

M. Deville commences by stating that if a tolerably rapid current of hydrogen is made to traverse a porous earthen tube, and the gas which escapes is collected, it is found to be, not hydrogen, but in round numbers, oxygen 21, and nitrogen 79. "Thus the hydrogen is dispersed through the atmosphere, and air is absorbed by the porous tube in virtue of endosmose; and in spite of the pressure of some centimetres of water, or mercury, into which the abducting tube is plunged, and which is maintained in the interior of the apparatus." If the porous tube is introduced into an impermeable porcelain tube, shorter than itself, and closed at each end with a cork, through which the porous tube is inserted, a space is enclosed in which any kind of gas can be admitted. For this purpose the corks are pierced so as to admit an exit and entrance tube of glass. The porous tube is similarly provided, and if a current of carbonic acid gas is made to traverse the space between the porous tube and the porcelain tube, while hydrogen is driven through the former, the hydrogen changes its place, and may be inflamed at the exit where the carbonic acid might have been expected, while the porous tube allows nearly pure carbonic acid to escape. These facts, observes M. Deville, are in accordance with the observations of Professor Graham and M. Jamin.

If the preceding apparatus is placed in a furnace supplied with dense fuel, affording a heat of 1100° to 1300° (C), it will suffice to demonstrate the spontaneous decomposition of water, a phenomenon which M. Deville terms *dissociation*. To accomplish this, vapour of water is passed through the porous tube, instead of the hydrogen in the former experiment, while carbonic acid gas traverses the space between the two tubes. The gases that emerge are collected over a bath containing potash, to absorb the carbonic acid, and received in small glass jars. When the furnace is in activity the tubes yield an explosive mixture of oxygen and hydrogen—the elements of water.

Thus it appears that part of the water is decomposed or "dissociated" in the porous tube, "the hydrogen attracted (*appelé*) by the carbonic acid in the annular interspace, has traversed the walls of the porous tube, and separated itself by

* *Comptes Rendus*, Feb. 2, 1863.

the simple action of a filter from the oxygen which remains in the interior tube. A considerable quantity of carbonic acid is attracted in a contrary direction, according to the rule established in the preceding experiments, and mingles with the oxygen." This is the broad explanation which M. Deville gives, but he remarks that the action is in reality more complicated; as, when the hydrogen comes in contact with the heated carbonic acid, some carbonic oxide is formed, and a certain quantity of the latter gas is found to replace the hydrogen. It is also difficult to avoid the escape of some hydrogen, which leaves the oxygen in excess, and the water contains enough air to effect the result. "The carbonic acid determines the separation of the gases by endosmose; but it may also act mechanically." M. Deville adds that he has proved that water heated in a platina tube almost to the fusion point of the metal, reconstitutes itself entirely as it makes its exit, or is not decomposed in a sensible quantity.

In explanation of these facts M. Deville states that the temperature of the combustion of hydrogen in oxygen is not equal to 2500° C, at which point the volume of the gases, estimated at 0° C, is multiplied tenfold, and beyond which the complete decomposition of water takes place. "But this decomposition is accompanied by a considerable absorption of latent heat, to the extent required to keep the molecules of oxygen and hydrogen at a distance beyond the radius of the sphere of their affinity. Thus the decomposition of a body resembles the ebullition of a liquid, the principal characteristic of which is invariableness of temperature under the same pressure." Admitting the comparison between decomposition and ebullition, M. Deville regards "dissociation," or partial decomposition at a temperature below the decomposing point, as resembling the evaporation of liquids below their boiling point. "If," he observes, "you shut up some water in a small vessel, at ordinary temperature, the evaporation is slight, on account of the tension that is produced when vapour is formed; but if you introduce a piece of chloride of calcium, the water evaporates until that substance is saturated, the tension remaining constant all the time." He imagines the carbonic acid to carry off the dissociated gases just as the chloride of calcium absorbs the vapour, and then the process of dissociation, like that of evaporation, is enabled to go on.

JAMAICA SEA-SIDE NOTES.

BY THE HON. RICHARD HILL.

Turtle.—The chelonians known by our fishermen distinctively as the green turtle and the hawk's-bill turtle, are common on the outside shoals of Old Harbour Bay. I went down to the beach where the turtlers were busy repairing and adjusting their nets preparatory to a start, and learned that the turtle are now (February) numerous, and that they will continue frequenting the shoals here in numbers till the month of July. The hawk's-bill turtle breed here, but the green turtle are migratory visitors. They come, as the fishermen express it, *clean*, that is free from barnacles, and are the yearly thrown off broods of the older ones to windward. They pass to leeward in successive schools, and only loiter among the marine pastures of *Testudinaria*, or the turtle-grass, to feed, and then they depart onward and deposit their eggs on the sands of the Central American shoals. The clean condition of their plates, or epidermic scuta, is the evidence that they are the full-grown young of the windward turtles in search of those unfrequented solitudes where alone they are reconciled to deposit their eggs and watch them into life. It would seem that the fields of turtle-grass are not extensive to windward, and that migration is necessary to enable the young generation to subsist. Had the extensive fields of the *Testudinaria* here been the unfished wildernesses that the Honduras sands are, or the shoals of the Mexican gulf are expected to be, the *Chelone Midas* would remain and breed, for the bay of Old Harbour is almost one continued pasture. But being pretty well resorted to for fish for the coast markets, the space, great as it is, is not solitary enough for the turtle, and they make it only a passing visit, and go further onward, but always moving socially.

It is in shallow waters, where the islets in the neighbourhood of the continent stand amid marine meadows, and afford occasional stretches of dry sand, that the turtles congregate to breed. The sea in these island clusters is tranquil, and the turtle may be observed browsing there, gathered into flocks, but so watchful and timid that they take flight upon any intrusion. They rise, however, soon to breathe; but if their confidence is not re-established, nothing promises safety but a dash onward into the open sea. Surprised upon land, they are a sure capture. Their power of moving onward is at best but a hasty scumble on shore. Caught and turned upon the back, they flounder and pivot about, but do not regain their fins.

The Snappers, *Mesoprions*, in one or other of the species,

are fishes of the market at all seasons ; some kinds are, however, only obtainable in particular places at particular times. The large fish known as the *Mutton Snapper,* is especially common at Old Harbour. It occurs, however, only upon some of the outer shoals in that Bay of Columbus's Seven Islands. It is a splendid fish, if we regard nothing but its colour and size, but in flavour it merits the same appellation, being full fleshed, with all the prevailing delicacy of the snapper. Its ordinary size in the market is from two to three feet, with more than common breadth for a snapper.

It is not easy to determine, in the absence of pictorial delineations, whether our Mutton Snapper be the *Mesoprion Campecheanus,* the *Pargo guacinango* of Mons. Poey's list of fishes of the coast of Cuba. The fish of the Campeachy banks in the Gulf of Mexico is roseate in colour, varied with bandelets, and ordinarily of three feet in size. The habitat is shallow water. The colour of our fish is subdued rose-red, slightly yellow at the tail, with opaline lines about the head, and a particular curved azure mark from the eye to the mouth.

The deep-water Silt-Snappers include some five different species, all similar in colour, with prodigiously large eyes, brilliant with bright yellow orbits. The market people point out the difference in the size of the eyes as indicating the different depths at which they were fished for by the line and taken, but in all instances at depths so fathomably great that the dilation of the air in the cavities of the socket sends the organ of sight out of its place in the head, while the natary bladder is forced into the mouth. The air, compressed by the deep water at a temperature very much below that of the surface, expanding suddenly, tears the vessels containing air out of their place, with the force of pellets from an air-gun, and the fish comes to the hand blind and choked.

The mode of fishing for deep-water Silts is very effective. The hooks are most favourably disposed for attracting the fish to the bait. A piece of iron is bent in such a way as to hold steadily a stone of some twenty pounds weight. The hooks are arranged in diverging lines from above the stone. The line is let down steadily till it touches the sandy bottom, or the hard and smooth silt. As soon as it reaches its resting-place it detaches the stone, and the baited hooks stretch out into their place. The lines are set and re-set every morning early. They are then taken up, and the fish taken off the hooks, from line after line in succession. The lines are buoyed when laid out, the play of the buoys indicating that fish are on the hooks. A single fishing canoe or so may be seen quietly paddling out to seaward with the first blush of day. It is on its way to the Silt-ground at two hundred fathoms depth, for the pur-

pose of laying out and taking in the deep-water lines. On hauling in these lines the iron that held the stone weight feels to the hand cold like ice. It has been ascertained that the temperature of the Caribbean Sea in depths of two hundred and forty fathoms is 48° Fahrenheit when the surface water is from 83° to 86°. This sudden depression under the tropics, so near the freezing point, gives a sensation as cold as ice.* It is in such cold strata of the sea that the *Mesoprion profundus* (Poey) and the *Ojanco* Snapper feed. The flesh is not very firm. It soon deteriorates after being drawn up from such frigid waters into an atmosphere expanding from 80° in the morning to 90° at noonday. It is a delicate-tasted fish, but only really good when cooked early as a breakfast fish.

It is not possible to see the deep-water Silts on the market-stall conspicuous for the brilliant rose-hues, without noticing their extremely large eyes. The sight of these dwellers in deep water would be very obscure if the breadth of the organ of vision did not, by the space from which the rays converge to the optic ganglion, supply by quantity the deficient intensity of light, so far below the surface.† The market-people know the fact that the size of the eye of a fish indicates the depth at which it feeds, and they understand, without any theoretic knowledge of the expansion of air by heat, that the sudden removal of the deep-water silts from the cold sea-depth to the warm atmosphere dilates the air of the bladder, and either breaks it in the abdomen, or sends it with violence into the œsophagus, while the enclosed air in the cavities of the eye expands, and thrusts that organ from the socket into the cheek of the fish.

Beyond the South Keys, and the South-east Key off Port Royal, where a line of reefs rises to the surface, along a coral wall of some three miles, there shoals out some four miles more of from eight to eighteen fathoms. This is the fishing ground for Snappers and Groupers. Out immediately further beyond, the bank descends with no bottom at one hundred and fifty fathoms. This is what the fishermen call the edge, and here they fish for deep-water Silts, and King Fish (*Scomber maximus*). A few mornings ago (December, 1861) the fishing boats were coming in with their take, from fish-pots and lines, when they observed a prodigious large Rock Hind, *Serranus catus*, following close upon the canoes. A line was baited. It tempted him to play round it, but he would not snap at it. The

* The deep-sea thermometer of the American Coast Survey, referred to by Lieutenant Maury in his *Geography of the Sea*, records a temperature as low as 35° F.

† "Leur vue dans les profondeurs où ils vivent, aurait peu d'exercise, si la plupart des espèces n'auraient, par la grandeur de leurs yeux, un moyen de suppléer à la faiblesse de la lumière."—*Histoire Naturelle des Poissons.* Cuvier et Valenciennes. Tome i. livre ii. chap i.

bait was changed from cut-up flesh to a small fish; immediately the Rock Hind drove at it, gulped it, and was taken. It was full five feet in length, one of the largest fishes of the kind that the fishermen were acquainted with. It was a perfect picture of a Grouper (*Serranus*).

We find *Sciænas* more numerously and more constantly in the market than any other family of fishes. The Red-mouth Grunt, as the *Hæmulons* are called, are much more common than any of the family. They feed in numbers on particular sands of the shore, and on particular grounds about the outside shoals and islets. They take the bait greedily. If the line for two feet be strung with some dozen pendant hooks, every hook will be found with a Hæmulon. It is amusing to sit in a boat anchored where they are known to frequent, and hear the outburst of grunting sounds with which they congregate around the baited line, and thrust each other aside for the shrimps, with which the hooks are set. It is only on sandy and silty shores that the seine can be used. Its capacious sweep, carrying the plumbed net down to the bottom, and scouring the ground as it is gathered in by the haulers in shore, whilst the boats are lifting it forward, brings into a diminishing circlet all the fish feeding on the silt, or in the ooze, and among these the Grunts will be usually found in abundance. It is not a fish of much flesh or flavour. The size is commonly small for a fish of the stall, but their colours and markings are very diversified, and they make a goodly show among the gatherings of the nets, with Gurnards and Rays, and young sharks, with *Corvinas*, or Drummers, and the *Leiostomas*, or Yellow-tail; both alliances of the *Hæmulons* and *Pristipomes*, all being feeders on the same clean sandy or silty shoals and beaches. The Hæmulons and Pristipomes are *Sciænas* of the division of united dorsals, with seven rays at the gills. In noticing the circumstances under which these fishes have acquired the name of Grunters and Croakers—*Crocros* and *Cricris*—and Drummers among the *Corvinas*, we shall quote Baron Humboldt's account of his first experience of their musical noises. "Towards seven in the evening," he says, "while in the South Sea, on the 20th of February, 1803, the whole crew were astounded by an extraordinary noise, which resembled that of drums beating in the air. It was at first attributed to the breakers. Speedily it was heard within the vessel, and especially towards the poop. It was like a boiling, in other words, like the noise of air escaping from a fluid in a state of ebullition. They began to fear that some leak might be in the vessel. It was unceasingly heard in all parts of the ship; and, finally, about nine o'clock it ceased altogether." Humboldt was not able to explain the cause of these sounds, but some twenty years after, Lieutenant

White, of the United States navy, published his voyage in the Chinese Seas, and in relating the sounds that astonished himself and his crew at the mouth of the Cambodia River, he acquainted us, that the interpreter informed him they were produced by a troop of fishes that had the faculty of attaching themselves to bodies by the mouth. The noises were heard around the bottom of the vessel. "It was," he says, "like a mixture of the bass of an organ, the sound of bells, the guttural cries of a frog, and the tones which imagination might attribute to an enormous harp; one might have said that the vessel trembled with it. These noises increased, and finally formed a universal chorus over the entire length of the vessel, and the two sides. In proportion as they went up the river, the sounds diminished, and finally ceased altogether." In a recent communication to "the British Association for the Advancement of Science," it is observed that, "every mariner who has anchored early in the spring on the coasts of Carolina, Georgia, and Florida, must have been annoyed by the drumming noise produced in the night, apparently at the bottom of the ship, and loud enough to deprive the stranger of rest until habit has rendered the sound familiar." Neither of these accounts seem distinctly to assign the noise to the *Sciænas*, but our fishermen are familiar with them. The sounds vary in their tones in different species of Grunts and Drummers. The fishermen know that by imitating them they can attract them to their nets, and they practise the imitation of their sounds successfully as a lure.

On reading these accounts one is disposed to ask whether Shakspeare in his play of the "Tempest," has not converted these marvellous natural phenomena into the supernatural one of his "Ariel," the tricksy spirit—

> "Where should this music be, in th' air, or th' earth?—
> It sounds no more,—and sure it waits upon
> Some god of the island.
> This music crept by me upon the waters;
> This is no mortal business, nor no sound
> That the earth owes."

MAN'S PLACE IN ZOOLOGY.

Professor Huxley's long-announced and long-expected work has at length made its appearance,* and contains little that was not previously made known through reports of his lectures during the last three years. It will not, however, be deemed of less value on this account, as it is the most important statement made by any great comparative anatomist on the position of man as a member of the animal kingdom. We object to the title of the new work, as *Man's Place in Nature* is a wider and more comprehensive question than his position in zoological classification, which is all that Professor Huxley endeavours to decide. The latter depends entirely upon physical structure, the former involves a host of considerations, metaphysical and psychological, which it is difficult to conceive that physical science will ever be able to explain. A scientific investigation of this description ought to excite no passions, nor ought any portion of it to be approached with prejudice, either because it seems likely to furnish support for a theory that has been espoused, or to provide weapons for the demolition of another theory that is repulsive to a particular mind. We all know that Professor Huxley, in common with Sir Charles Lyell, Dr. Hooker, and many other scientific men, leans to the Darwinian hypothesis as offering the most probable solution of the origin of species and the succession of organic forms; and all who hold such views look upon some kind of monkey as having possibly been the very great-grandmother of humanity, thousands or millions of ages ago. If man's dignity is annoyed by this supposition, they remind him of the humble beginning of every individual. They show him that the human egg, from which he is slowly hatched, is not distinguishable in its earliest stages from the germ of some lower creature. The young dog, for example, and the incipient prince, or philosopher, begin alike as a germinal vesicle inclosed in a microscopic bag, containing "a mass of viscid nutritive matter—the yelk." The first terms of the development are much the same, whatever the creature is ultimately to become; but after a little while the embryos diverge, and progress in their divergence, in proportion as the adult animals are destined to differ, so that the "embryos of a snake and a lizard remain like one another longer than do those of a snake and a bird, and the embryo of a dog and of a cat remain like one another for a far longer period than do those of a dog and a bird, or of a dog and an

* *Evidence as to Man's Place in Nature.* By Thomas Henry Huxley, Fellow of the Royal Society. Williams & Norgate.

opossum, or even than those of a dog and a monkey." As recently shown in our pages, Balbiani has traced the egg generation down so low as the ciliated infusoria, and with the explanations given by Quatrefages, every living thing may have sprung directly or indirectly from a similar source. But, in point of fact, whatever theory may prove correct, it is what we are, and not what we come from, that gives us importance. We take no pride in being composed of carbon, oxygen, hydrogen, phosphorus, iron, and so forth; and the material forces which build us up would not be the less under Divine command if their mode of action should be found to differ from what we formerly conceived.

If Professor Huxley instituted his comparisons between man and the anthropoid apes for the express purpose of sustaining Darwin's hypothesis, and was blind to all evidence of an opposite character, we should attach little importance to his anatomical labours; but he is singularly honest as an inquirer, and endowed with an unusual proportion of that philosophic quality which makes the real student the devoted worshipper of truth, and prevents his being the slave of any theory to which doubt can reasonably attach. We, therefore, take his account of bones, or brains, as so many explanations of structural fact, complete as far as they go, and neither distorted nor clipt to adapt them to preconceived views. A less honest writer might have been tempted to claim the Neanderthal skull, spoken of in our last number, as a link between the monkey and the man; but Mr. Huxley, while characterizing it as the "most pithecoid of human crania yet discovered," points out that, from its dimensions, it must have held as much brain as the average of Polynesian and Hottentot skulls; and he observes that so large a mass of brain "would suggest that the pithecoid tendencies did not extend deep into the organization," and that the bones of the skeleton confirm this opinion, so that "in no sense can the Neanderthal bones be regarded as the remains of a human being intermediate between men and apes."

With these remarks we may proceed to consider what are the physical and structural relations of man to the anthropoid apes. First, it appears that the distinctions of two-handed and four-handed—Bimana and Quadrumana—will not hold good, as the gorilla and other apes possess true feet, which differ widely from real hands. Professor Huxley observes, "the skeleton of the foot is very like that of the hand in some respects. Thus there are three phalanges in each of the lesser toes, and only two in the great toe, which answers to the thumb. There is a long bone termed *metatarsal*, answering to the metacarpal for each digit; and the *tarsus* (which corresponds with the carpus, or wrist) presents four short polygonal bones in a row, which cor-

respond very closely with the four carpal bones of the second row of the hand. In other respects the foot differs widely from the hand. Thus the great toe is the largest digit but one; and its metatarsal is far less moveably articulated with the tarsus than the metacarpal of the thumb with the carpus. But a far more important distinction lies in the fact that, instead of four more tarsal bones there are only three, and that these three are not arranged side by side, or in one row. One of them, the *os calcis*, or heel bone, lies externally and sends back the large projecting heel; another, the *astragalus*, rests on this by one face, and by another forms, with the bones of the leg, the ankle joint; while a third face, directed forwards, is separated from the thin inner tarsal bones of the row next the metatarsus by a bone called the *scaphoid*." The tendons and muscles of feet and hands also present certain differences; "but perhaps the most absolutely distinctive character about the muscles of the foot is the existence of what is termed the *peronæus longus*, a long muscle fixed to the outer bone of the leg, and sending its tendon to the outer ankle, behind and below which it passes, and then crosses the foot obliquely to be attached to the base of the great toe." Keeping these distinctions in view, it appears that the gorilla's hand is clumsier, heavier, and with a shorter thumb than that of a man, and that his hind limb ends in a true foot of a prehensile character, "differing from that of man not in any fundamental character, but in mere proportions, in the degree of mobility, and in the secondary arrangements of its parts." Thus the gorilla has an inferior hand and an inferior foot, and throughout his whole structure a similar difference prevails, although at every point comparisons may be made.

When we come to the brain of the anthropoid apes there is a most marked and striking inferiority of size, both absolute and relative. The differences between a gorilla's skull and a man's are pronounced by Professor Huxley to be "truly immense," and it is the covering of a strikingly inferior organ. The smallest adult human skulls, of which there is certain evidence, have a capacity of not less than 62 cubic inches, while the most capacious gorilla skull known does not exceed 34½ cubic inches. This circumstance is sufficient to mark the enormous interval which separates "Man's place in nature" from that of the gorilla; but diversity of size is not in itself of much importance in zoological classification, which gives a greater prominence to structure. But even in cranial capacity "men differ more widely from one another than they do from the apes, while the lowest apes differ as much, in proportion from the highest, as the latter does from man." The structure of the brain of the ape has been the subject of an unfortunate controversy carried

on for some years by Professor Owen, who finds, or imagines distinctions which no other anatomist is able to see, and which, if established, instead of being disproved by investigation, would not in the least help to account for the glory of the man, or the inferiority of the brute. We could not present a more concise account of the whole brain question than in the words of Professor Huxley, who says :—

"The brain of a fish is very small compared with the spinal chord into which it is continued, and with the nerves which come off from it; of the segments of which it is composed—the olefactory lobes, the cerebral hemisphere, and the succeeding divisions—no one predominates so much over the rest as to obscure or cover them; and the so-called optic lobes are frequently the largest masses of all. In reptiles, the mass of the brain, relatively to the spinal chord, increases, and the cerebral hemispheres begin to predominate over the other parts; while in birds this prominence is still more marked. The brain of the lowest mammals met with, such as the duck-billed platypus, and the opossums and kangaroos, exhibit a still more definite advance in the same direction. The cerebral hemispheres have now so much increased as more or less to hide the representatives of the optic lobes, which remain comparatively small, so that the brain of a marsupial is extremely different from that of a bird, reptile, or fish. A step higher in the scale, among the placental mammals, the structure of the brain acquires a vast modification—not that it appears much altered externally, in a rat or a rabbit, from what it is in a marsupial, nor that the proportions of its parts are much changed; but an apparently new structure is found between the cerebral hemispheres, connecting them together, as what is called the '*great commissure*' or '*corpus callosum.*' The subject requires careful re-investigation; but if the currently received statements are correct, the appearance of the '*corpus callosum*' in the placental mammals is the greatest and most sudden modification exhibited by the brain in the whole series of vertebrated animals—it is the greatest leap anywhere made in nature's brain work. For the two halves of the brain being thus once knit together, the process of cerebral complexity is traceable through a complete series of steps from the lowest rodent or insectivore to man; and that complexity consists chiefly in the disproportionate development of the cerebral hemispheres and of the cerebellum, but especially of the former, in respect to the other parts of the brain."

"In the lower placental mammals the cerebral hemispheres have the proper upper and posterior face of the cerebellum completely visible when the brain is viewed from above; but in the higher forms the hinder part of each hemisphere,

separated only by the *tentorium** from the anterior face of the cerebellum, inclines backwards and downwards, and grows out as the so-called 'posterior lobe,' so as at length to overlap and hide the cerebellum. In all mammals, each cerebral hemisphere contains a cavity which is termed the 'ventricle;' and as this ventricle is prolonged on one hand forwards, and on the other downwards into the substance of the hemisphere, it is said to have two horns or 'cornua,' an 'anterior cornu,' and a 'descending cornu.' When the posterior lobe is well developed, a third prolongation of the ventricular cavity extends into it, and is called the 'posterior *cornu*.'"

In the lower and smaller forms of placental mammals the brain is either smooth or evenly rounded; in the higher order the grooves and convolutions are conspicuous and complicated, "until in the elephant, the porpoise, the higher apes, and man, the cerebral surface appears a perfect labyrinth of tortuous foldings." "When a posterior lobe exists and presents its customary cavity—the posterior cornu—it commonly happens that a particular *sulcus* appears on the inner and under surface of the lobe, parallel with and beneath the floor of the cornu, which is, as it were, arched over the roof of the sulcus. It is as if the groove had been formed by indenting the floor of the posterior horn from without with a blunt instrument, so that the floor should rise as a convex eminence. Now this eminence is what has been termed the 'hippocampus minor,' the 'hippocampus major' being the larger eminence on the floor of the descending cornu. What may be the functional importance of either of these structures we know not."

We have cited Professor Huxley at this length because the argument on brain structure has been carried on with absurd virulence, and as though man would be an injured individual if an ape possessed a "posterior cornu" and a "hippocampus minor." Notwithstanding that some drawings, confessedly made in error from damaged brains, give a contradictory impression, the leading English and continental anatomists who have had the opportunity of personal observation, are agreed (Professor Owen excepted) that every marmoset, American monkey, old world monkey, baboon, or man-like ape has its cerebellum entirely hidden, posteriorly, by the cerebral lobes, and possesses a large posterior cornu, with a well-developed "hippocampus minor." On the contrary, the lemurs have the cerebellum partially visible from above, and the posterior cornu and hippocampus minor are more or less rudimentary.

Until the use of every portion of the brain and the effect of

* A sort of parchment-like shelf or partition, which in the recent state is interposed between the cerebrum and the cerebellum.—*Op. Cit.* p. 99.

enlarging particular parts is distinctly understood, we cannot expect that cerebral anatomy will enable us to appreciate the distinction, so far as organization is concerned, between the man and the monkey. But we have already seen that the size of the human brain is immensely greater than that of the anthropoid ape, and Professor Owen confesses that he cannot appreciate the distinction between the psychical phenomena of a chimpanzee or of a Boschisman, or of an Aztec, "as being other than a difference of degree." It is impossible to deny that animals possess moral faculties, as well as a rudimentary reason; and when we take creatures that have had for generations the advantage of human care and companionship, such as the dog, the virtues of fidelity, self-denial, and devotion are conspicuously exhibited, and the simple elements of ratiocination plainly seen. Still we have no reason to believe that our dogs are more moral or more intelligent than those which our forefathers trained, nor do we see any ground for supposing that our descendants will discover the means of carrying dog-progress to much higher perfection than we have achieved. Some naturalists place the anthropoid apes higher in the scale of intelligence than the dog or the elephant, but we fancy they do so in compliance with a physiological theory, rather than from an investigation of fact. It is also important to bear in mind a suggestion of Professor Rolleston, cited by Sir C. Lyell, that even if it were proved that the differences between man's brain and the ape's are differences entirely of quantity, there is no reason in the nature of things why so many and such weighty differences should not amount to a difference in kind. We ought indeed to guard carefully against false analogies drawn from physical nature when we come to speak of the worlds of intelligence, emotion, and thought. The contraction of a muscle is palpably an action of physical force, and if a thousand fibres contract together with equal intensity, they will be able to move a thousand times as much matter as if one of them had contracted alone. The action of a large brain may not, however, be merely a greater action of precisely the same kind as that which a smaller brain of the same pattern can exert; and without going to the monkey, or the quadrupeds for illustrations, we may reasonably doubt whether the work done by the well-formed and well-cultivated brain of a European philosopher is nothing more than an amplification of the task performed by the very inferior and less cultivated brain of the Australian savage. Among the lowest specimens of humanity, travellers can trace no capacity for forming abstract or general conceptions of any kind. Their arts are few, simple, and, in the main, purely imitative, and their most *obvious* difference from the lower animals is the possession of language in a very elementary form. Their real

difference is, however, a capacity for progress, if subjected to higher influences, which cannot be found in any brute. Give time enough and a sufficient action of civilizing agencies, the savage will grow more distinctively human, and, as generations succeed, the average cerebral development will improve and render possible a still further stage.

History has never traced the growth of any important people from the lowest to the highest stage, but we are nevertheless justified in believing an improvable reason to be the special gift bestowed upon man. How comes this gift? The physiologist shows a certain correspondence of structure with function, but we know nothing of the nature of mind, although on every hand we perceive its effects. Were it possible, as Arabian legends and fairy stories tell, for a human being to be transformed into an ass or a dog, what would the human soul do with the inferior brain assigned to it by the change? We should expect, as these legends and stories relate, something more than asinine or canine ways, and Professor Huxley suggests important considerations when he protests against the assumption that intellectual power depends altogether on the brain. That organ he considers supplies one condition only, the others being chiefly the organs of the senses and the motor apparatuses, especially those which are concerned in prehension and in the production of articulate speech. He observes that a man born dumb would be capable of few higher intellectual manifestations than a chimpanzee if he were confined to the society of dumb associates, although his brain might not exhibit the slightest difference from that of an intelligent person. We admit the necessity for considering what machinery for collecting information, and for executing its commands, the brain may have at its disposal, and can easily conceive that a colony of dumb men, if able to get a living, would be little better than chimpanzees. This idea has been well put forth by a blind surgeon, Mr. Bird, who has long protested against educating and segregating the blind with the blind, and thus depriving them of the healthy action, and of the ideas that belong to the people who can see; but if it were possible for a race of dumb men to exist for a few generations without any power of speech, should we not find that their cerebral organization would deteriorate? And even if the brain of a single dumb man which had not been exercised could not be distinguished from the well-exercised brain of "a highly intelligent and cultivated person," would not the fault be in the investigator, and in the state of the science by which he was informed? Does not the brain bear some permanent record of its previous states, or are all the phenomena of memory purely psychical and not cerebral occurrences? In an interesting collection of anecdotes

strung together with little philosophy by Dr. Forbes Winslow,* the reader will find under the head of "Psychology and Pathology of Memory" a variety of illustrations that what the writer terms "mental impressions" are indestructible. Thus, the Countess of Laval in her sleep spoke the language of Brittany, although when awake she had so completely forgotten it, that when her own words were repeated to her they conveyed no corresponding ideas; and then there is Coleridge's story of an ignorant peasant girl whom the priests and monks supposed to be possessed by "a very learned devil," because she spouted Latin, Greek, and Hebrew, during a nervous fever attack, the explanation being that when nine years old she had lived with a clergyman who was in the habit of reading ancient authors as he walked up and down a passage leading to the kitchen door. In these cases the anatomist would not have known how to look for traces of the past cerebral action which was the foundation of the strange utterances; but they were no doubt there, like sun pictures, invisible until the right mode of development is tried.

We do not undertake to form opinions for our readers on these subjects. Our function is the faithful narration of what men of science are doing. There is nothing less satisfying and more annoying than the common run of reviews, which seem designed to prevent the public from knowing what the books, so treated, are about. What Lyell or Huxley and other eminent men say and think concern us all. The last believes that the philosophy which he unfolds will teach man to "discern in his long progress through the past, a reasonable ground of faith in his attainment of a nobler future;" and the first observes that "so far from having a materialistic tendency, the supposed introduction into the earth at successive geological periods, of life—sensation, or instinct—the intelligence of the higher mammalia bordering on reason—and lastly, the improvable reason of man himself presents us with a picture of the ever increasing dominion of the mind over matter."

The substance of this faith may be held by members of divers schools of science, and those may agree concerning man's destiny who differ as to his origin, while all may coincide in the advice to—

> "Move upward, working out the beast,
> And let the ape and tiger die."

We repeat that Man's place in Nature is a wider question than his position in zoology, and while the last is determined merely by his structure as an animal, it matters not whether, as Huxley proposes, he is arranged at the head of the primates or in an order by himself.

* *Obscure Diseases of the Brain and Mind.*

TRADE MARKS—ANCIENT AND MODERN.

BY H. NOEL HUMPHREYS.

So much has recently been said and written on the subject of trade marks, and the advisability of adopting some stringent measures to secure their genuineness, that it may not be uninteresting to examine the character of certain usages, with regard to commercial stamps, which prevailed among the states of ancient Greece, and which archæological research has recently brought to light. Without entering upon an account of the trade marks used at the present time, and their fraudulent imitation in various branches of manufacture, from cutlery to Eau-de-Cologne, it may be as well just to call to mind, *en passant*, the case of the famous Cross Cotton, which in the names of Cartier *versus* Prichard, Cartier *versus* May, and Cartier *versus* Lund, occupied the Court of Chancery, in the year 1861, on June 27th and July the 12th and 18th; the second case being an application to commit the defendant for breach of an injunction already granted.

The ancient trade marks about to be described do not belong to a precisely analogous branch of manufacture, but will serve equally well to show the feeling entertained by the Greeks, that in commercial transactions a distinguishing mark, forming a dependable guarantee, was very desirable. In order to render this kind of guarantee a reliable one, it was undertaken by the state itself, and not left to the good faith of individuals as with us; the consequences of which we have recently seen. The worst result of falsifying marks is, that the loss of character in foreign markets which follows, recoils upon the general commerce of the country rather than upon the fraudulent imitator, as the low price of an inferior article secures to it a certain amount of circulation after all faith in the qualities of the superior product has been destroyed. It was with this conviction that the Governments of Greek states undertook to guarantee the quality or quantity of a staple product by the application of a national seal. The manner in which our Government endeavours to prevent the evasion of duties on patent medicines, by forbidding their sale without a stamp, is a course which produces, accidentally, a somewhat analogous result, as, in addition to securing the Government duty on every box or bottle that is sold, it serves at the same time as a guarantee that the article so stamped is the thing it professes to be, as few individuals would venture upon the forgery of the official stamp of the Government. We have

indeed a custom, which though not that of the Government, possesses nearly an equivalent value, as being that of a powerful national Guild—the gold and silver marks of the Goldsmiths' Company having proved as efficient as any Government stamp could be, in serving as a dependable guarantee for a certain amount of purity in articles professed by their manufacturers to be of gold or silver. It seems, therefore, that if a general system either of guild marks or state marks were adopted, the fraudulent use at present made of the trade-mark system would be rendered unprofitable, and therefore extinguished.

Almost the only trade marks of the ancients that have come down to us are those in the wine trade. Thiersch and Stoddart first described the official stamps or marks on the amphoræ, or wine vessels, of the little island state of Thasos, celebrated for its wines; but these antiquaries had only discovered three Thasian marks, while they described a number of those of Rhodes, Cnidos, and other places. The Rhodian inscriptions of this class are fuller than those of any other place of which similar remains have been brought to light, and have on this account proved of some literary value. For instance, the name of the month during which the stamping took place is often added to that of the stamping magistrate, and in this way the names of seven Rhodian months and the intercalary month have been recovered; five only being known previous to the discovery of the stamped amphoræ. Curious peculiarities of local spelling of Greek words also occur, and the titles conferred on the stamping magistrates by different states have also been recovered, as in some places they were added to the names. Thus we find the stamping officer styled ιερεις at Rhodes; δημιουργος at Cnidos; and αστυνομος at places on the Black Sea.

This stamping, or rather sealing, was analogous to that of stamping or sealing the current coin with the device of the state, to guarantee that each piece was of a certain weight and purity; and as in the Grecian style of coinage, when in its highest state of development, the name of the stamping magistrate appeared on the coin, by the side of the device of the state seal, so on the amphoræ of the wines intended for exportation the name of a magistrate accompanied the stamp of the official seal, and sometimes appeared by itself. The official seal used for the purpose of trade mark is often the same as that which appears on the national coinage. It is, however, frequently of distinct design, though nearly always having reference to the monetary type. The following illustrations and descriptions will elucidate more fully the nature of these stamps. They are principally taken from those of Thasos, recently discovered by M. Stephanos Comanoudis.

The stamp, No. 1, on the handle of a Thasian amphora, consists of the figure of an archer, which is a rude copy of that on the fine gold staters of Thasos, of ancient make. It represents Hercules in the act of drawing a bow. In some of the stamps of this class the archer is represented in a standing attitude. The name of the magistrate is indistinct in the stamp under description. The portion of the inscription attached to this stamp is illegible for want of the context.

No. 1.

On the stamp, No. 2, the bow only is represented as an early emblem of Hercules. It is sometimes accompanied by a club, to distinguish it from the bow which is sometimes used as an emblem of Apollo. On this stamp the name of the state is nearly perfect, and precedes that of the stamping magistrate. It stands ΘΑΣΙΩΝ, in the genitive plural (of the Thasians). The name of the magistrate, ΑΝΑΡΙΩΝ, is probably miswritten with an Ω, instead of an O, giving it the appearance of a genitive plural, while it is doubtless intended to be in the nominative case singular.

No. 2.

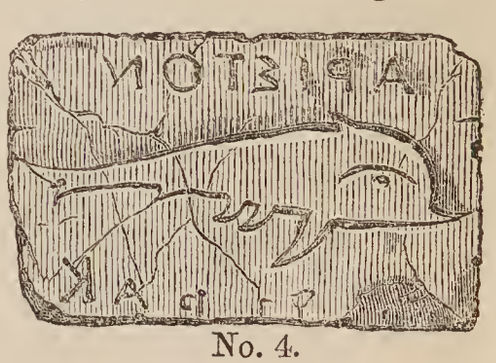
No. 3.

The type of another stamp is a short sword, which is, in all probability, another attribute of Hercules. This stamp also has the beginning of the word ΘΑΣΙΩΝ (of the Thasians).

Among some of the types of these seals which cannot be directly traced as Thasian types are the diota or two-handed amphora, a symbol generally considered as sacred to Bacchus, as shown in the illustration, No. 3; or the horn of Abundance, or occasionally a dolphin; while some have a rude head of Diana, very similar to that on an ancient Thasian coin described by Eckhel. The name on this stamp, which, like most of the others of this series, evidently belongs to a late period of ancient Greek commerce, is incomplete, and it is written from right to left, or, as we should say, backwards; an affectation of ancient style* of which we are not without abun-

* It will be remembered that all the earliest forms of Greek writing run from right to left.

dant examples in the present day, as in the occasional use of old English or Gothic letters in decorative inscriptions. The imperfect name is probably APIΣTON (Ariston), as found complete on the stamp of the dolphin type (No. 4), where it is also written in the ancient manner, from right to left, though the workmanship of the stamp plainly indicates that it belongs to a period long posterior to that during which Greek writing ran in that direction.



No. 4.

It has been stated, as the general supposition, that the names accompanying the official stamp were invariably those of the state official; but it appears probable that when the name appears in the genitive case, as it occasionally does, it may be that of the producer himself; while a second name, which often occurs, may be that of the stamping magistrate.

On some of the most recent of these antique stamps the sigma (Σ) is written in what is called the square manner—that is, in nearly the form of a C, as indeed it is on late Greek coins.

The theta (Θ) is also sometimes abandoned for the simpler and softer sound of S; and thus we find on some of these handles of amphoræ what ought to be ΘΑΣΙΟΩΝ (Thasiōn) written as ΣΑCΙΩΝ (Sasiōn). The Thasian money of late date has often debased spelling of a similar kind, as ΘΑΤΙΩΝ for ΘΑΣΙΩΝ. It may be stated here the amphoræ of different states are, in many instances, easily distinguished by archæologists without reference to their description; for instance, the clay of Thasos differs from that of Rhodes or Cnidos in being lighter coloured, and also coarser. The Thasian vessels are also less baked than those of Rhodes.

Such are a few of the points of general interest to be met with in the study of these broken remains of the ancient amphoræ that once contained the Thasian wine, in addition to the knowledge acquired through their evidence that the Greek states took upon themselves the regulation of the trade marks of the articles of staple produce, instead of leaving them at the mercy of the caprice or dishonesty of individuals. The site of almost every historic Greek city, whether at present occupied by a modern town or not, has in its vicinity some mound or mounds formed of the ancient refuse of the place, often consisting in great part of accumulations of broken pottery. It is in such of the mounds, on the high ground above the Piræus, that M. Stephanos Comanoudis, professor of Latin in the University of Athens, has discovered a vast number of the stamped handles of the amphoræ of Thasos, of which the illustrations of the present article are examples. M. Comanoudis proposes to

publish the result of his archæological labours, which will form a very interesting volume, opening up several new channels of information concerning the ancient commerce of Athens, and the laws by which its transactions were regulated; among which may perhaps be found many hints for the better regulation of our own system of trade marks and stamps.

THE EXAMINATION OF TADPOLES.

As we are now in the midst of the season of tadpoles, our microscopic readers may be advantageously reminded of the researches of Mr. Whitney, laid before the Microscopic Society of London in 1861, and briefly described in a former number of this magazine. Mr. Whitney recommends the binocular microscope to assist in the process of looking into the tadpole, which should be placed on its back. He observes, when matters are thus arranged, "before us is the beating heart, a bulbous-looking cavity, formed of the most delicate transparent tissues, through which are seen the globules of the blood, perpetually, but alternately, entering by one orifice and leaving it by the other. The heart appears to be slung, as it were, between two arms or branches extending right and left. From these trunks the main arteries arise. The heart is enclosed within an envelope or pericardium. This pericardium is, perhaps, the most delicate, and is certainly the most elegant beauty in the creature's organism. Its extreme fineness makes it often elude the eye under the single microscope; but under the binocular its form is distinctly revealed. Then it is seen as a canopy or tent, enclosing the heart, but of such extreme tenuity that its folds are really the means by which its existence is recognized." To the right and left of the heart the lungs should be looked for, in which the circulation can be seen in the middle and later periods of its life. In its first stage the tadpole "respires exclusively by gills," which are very interesting organs to watch.

Mr. Whitney considers that in the middle and later stages of the tadpole's metamorphoses, in which it is neither a reptile nor a fish, the "three large arteries which arise from the heart become the cephalic, the pulmonary, and the aortic trunks." The cephalic artery, he asserts, "receives into it small branches from the subdivisions of the pulmonary artery, so that there is a direct communication between these two vessels." The second trunk he considers the true pulmonary artery, which enters and is distributed through the lung; and the third trunk, he

states, "also enters and passes through the lung, inosculating in its course with branches of the pulmonary artery, and then emerges from the floor of the lung to enter the abdomen, and with its fellow form the aorta or great systemic trunk." Previous observers had not arrived at results presenting so complete an aeration of the tadpole's blood during its active and carnivorous and even cannibal stage of existence; but Mr. Whitney was careful to examine specimens sufficiently transparent. The great obstacle to this is the opacity usually presented by the coil of intestine. Mr. Whitney tried purgative medicines as a remedy, but without effect. He succeeded, however, by placing his tadpoles upon water diet, when the intestine could receive little solid matter, and ceased to obstruct his view.

When the tadpole is lying on his back, the liver is a lobed organ below the left lung; and still lower is the oval kidney, lying close to the caudal vein.

The reader will be assisted in tracing the blood-vessels by another quotation from Mr. Whitney, who observes, "all these are closely connected with the corresponding lung. The upper one—the cephalic—runs along the upper edge of the lung, and gives off, in its course, a branch which ascends to the mouth. The cephalic artery continues its course around the lung (forming, to all appearance, the *edge* of that organ), until it suddenly curves upwards and backwards, and reaches the upper surface of the head, when it dips between the eye and the brain, towards which it is evidently travelling." Enough has probably been said about the two other arterial trunks, but those who wish for further details can consult Mr. Whitney's paper.* We may add that his most successful tadpole looked quite opaque when taken from a jar containing green weeds, but proved on examination to be perfectly transparent. He had no red blood, and his other fluids were equally colourless.

* *Quarterly Journal of the Microscopical Society*, Jan., 1862.

VARIABLE STAR OBSERVATIONS.

BY GEORGE KNOTT, LL.B., F.R.A.S.

In endeavouring to lay before the readers of the Intellectual Observer a short account of the method of observing variable stars, I am desirous, at the outset, of disclaiming any pretensions to originality in what I shall have to advance. For the substance of the following paragraphs I am principally indebted to various papers by N. R. Pogson, Esq., Director of the Royal Observatory at Madras, who has prosecuted this branch of research with much assiduity and deserved success.

Preparatory to commencing operations on a variable star, the following equipment is necessary:—An approximate chart of its neighbourhood, and a list of stars whose magnitudes have been carefully determined, to be used as points of reference in fixing its magnitude at the several times of observation. The "comparison stars" should be lettered or numbered for convenience of reference, corresponding letters or numbers being affixed to them on the chart.

Thus furnished, the observer compares the variable with such of the "comparison stars" as may not, at the time, too widely differ from it in brightness, and carefully estimates the differences in tenths of a magnitude. Several values, which, after a little practice, will be found to be fairly accordant, are thus obtained for the magnitude of the variable at the time of observation, and the mean of these is assumed as its magnitude for the night. For convenience I shall term these "nightly means."

The preceding remarks will be best illustrated by an example, which I take from my journal.

"Jan. 7th, 1862.—U Geminorum. Estimated equal to — b + 6 : d—5 : e—10 : f—13 : (the differences being expressed in tenths of a magnitude)." The assumed magnitudes of the "comparison stars" are as follow,—b = 9·3 : d = 10·3 : e = 11·0 : f = 11·3 : —hence, the resulting values for the magnitude of the variable are,—9·9 : 9·8 : 10·0 : 10·0 :—the mean being 9·9, which is, probably, not very far from the truth.

The next step in the process is to project all the "nightly means" on cross-ruled paper, taking the dates of observation for the abscissæ and the corresponding magnitudes for the ordinates. A curve is then drawn by hand evenly among the points thus laid down, so as to leave as few discordances as possible; this is termed the "light-curve," and the epoch of *maximum* or *minimum*, as the case may be, is determined by reading off the date on which the curve passes through its

highest or lowest point. If, owing to slowness of change in the magnitude of the variable, the "light-curve" is flattened near the vertex, the date of maximum or minimum cannot accurately be determined by inspection. In such cases the following expedient may be adopted:—Bisect the lines joining points where the "light-curve" in ascending and descending passes through equal magnitudes; among the points thus obtained draw a curve, producing it till it cuts the "light-curve;" the point of intersection is assumed as the epoch of maximum or minimum. A discussion of several observed maxima or minima gives the *period* of the variable star, which, with the range of variation, is in some cases found to be remarkably irregular.

I have thus endeavoured to give a general idea of the mode of observing variable stars. Various difficulties will doubtless suggest themselves to the reader as likely to occur in practice. Of these the most serious, probably, is connected with the obtaining charts and lists of "comparison stars." I am in hopes, however, that this difficulty will be before long removed by the publication of the Hartwell Variable Star Atlas, commenced by Mr. Pogson, at Dr. Lee's observatory, and now in process of completion at Madras. This valuable work will in all likelihood do much to popularize an interesting branch of inquiry, and one in which the zealous amateur may labour with every prospect of success.

SPECULA FOR TELESCOPES.—DOUBLE STARS.—OCCULTATIONS.—TRANSITS OF JUPITER'S SATELLITES.

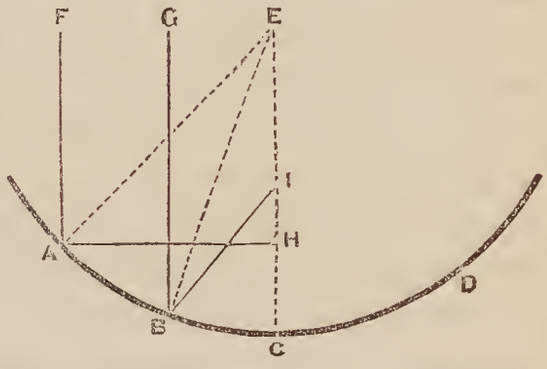
BY THE REV. T. W. WEBB, F.R.A.S.

The process of grinding and polishing specula, whether of metal or glass, for optical purposes, is not merely a laborious or, at least, tedious one from the hardness of the material, but one of much difficulty from the extreme delicacy of some of the operations, and the impossibility of obtaining the highest perfection which art can accomplish, by any other than what may be termed an indirect mode of working. The circular disc of metal or glass has, in the first instance, to be ground on one of its faces to the required curve, by means of a tool of brass or iron of similar form to itself, and not much differing in size. This is effected by working one surface on the other, with a due intermixture of circular strokes and straight ones carried in all possible directions, employing as an abrading material moist emery—a mineral powder of an extremely

hard nature, which is obtained of progressive degrees of fineness by agitating it with water, and collecting the sediment after different intervals of time. As the grinding (which is a very slow operation) proceeds, finer and finer qualities of emery are successively brought into use, till the scratches produced in the earlier stages are effaced, and an exquisitely smooth and, to some extent, reflective surface is the result, when the process of grinding is complete; though metal is occasionally still more delicately smoothed by being subsequently applied to a tool of whetstone or slate. Polishing is effected on a similarly-shaped tool covered with a layer of paper or pitch, either of which materials will admit of the polishing powder's imbedding itself and retaining its position to the last. Several powders may be employed for this purpose: putty powder, which is said to be a mixture of the oxides of tin and lead, has been often used; but the preference seems now to be given to the *rouge* of the jewellers—in chemical language, the sesquioxide of iron, as producing a blacker lustre: with this substance a process corresponding with that of grinding is continued, till a perfectly equable and splendidly reflective polish is obtained. In all this, nothing more is involved than a considerable expenditure of time and labour; the latter, however, admits of being greatly reduced by the employment of machinery,* which has of late been extensively introduced with admirable results. Much care also must be taken to avoid the slightest inequality of pressure or irregularity of action, as well as to efface all scratches and prevent their reproduction; though this is a matter of secondary importance, as affecting the appearance, but scarcely at all the performance, of the speculum. The final result will be, under experienced management, a mirror of great splendour to the eye, but of inferior performance in the telescope; the image, fairly distinct with a low power, becoming less sharp and defined than it ought to be under deeper magnifiers. The reason of this defect may be easily rendered intelligible. The brightest possible polish is of no value unless it is wrought out upon a figure, as it is called, or curvature of surface, capable of reflecting the rays accurately to a single point or *focus*, and thus forming a picture of the object whence they proceed, distinct enough to admit of being highly magnified; and hence, while an inferiority of polish induces only a want of brilliancy in the image, a deficiency in correctness of figure occasions a confusion and haziness far more prejudicial

* With large diameters, the increase of weight and friction becomes very inconvenient. The late Mr. Ramage, of Aberdeen, an ingenious artificer, who succeeded Herschel I. in point of time, astonished the London workmen by the size of the specula which he could work by hand, even (if I recollect right) up to fifteen inches.

to the quality and value of the instrument. Now, the form naturally resulting from working two surfaces equably upon each other in all possible ways for a length of time, will be that of a portion of a sphere, no other concavity having the same amount of curvature in every possible direction; and therefore the figure of a speculum finished in the way just described would be spherical; but a spherical surface is incapable of collecting parallel, or nearly parallel, rays, such as reach us from the heavenly bodies, into one point; and therefore our mirror would, after all, disappoint our expectations. The cause of the incapacity of such a surface to collect the whole of a parallel pencil of rays in the same point may be illustrated by the following diagram; if we bear in mind the first principle of catoptrics, that whatever angle the incident ray makes with a perpendicular to the reflecting surface, it will be reflected at a precisely equal angle on the other side of the perpendicular.



Let ABCD be a section of a spherical mirror, of which E is the centre; then EA and EB will be perpendiculars to the surface, and the incident parallel rays, FA and GB, will be reflected so as to make the angle EAH = FAE, and also EBI = GBE. But the ray AH, instead of intersecting the ray BI in I, as it ought to do, to assist it in forming the image, will, from the properties of the sphere, the curvature of which is too rapid, be reflected to another point, H, nearer to the surface of the mirror, so that the focus of the more distant, or marginal, will be shorter than that of the more central rays; and instead of the intersection of the whole incident pencil taking place in one point, there will be a continued succession of intersections, or foci, each closer to the surface of the mirror in proportion as the reflecting point, or rather zone, to which it corresponds, is further removed from the centre. Hence results the test of figure so well known to opticians, the aspect of the luminous disc formed by a large star on each side of the focus: if the disc at some distance within the focus is bordered by a bright and sharp limb, while the appearance is reversed and the centre brightest on the other side of the focus, it indicates that unduly rapid convergence of the marginal rays which is the sure indication of a spherical form; hence also follows the advantage, with telescopes containing such imperfectly figured specula, of contracting the aperture by a diaphragm, as the error increases with extraordinary rapidity in proportion to the distance from the centre. Such is the defect inseparable from the spherical figure; it is fortunately remediable, but only, at

least in the Newtonian or Lemairean* construction, by transforming the circular into a parabolic curve, the property of which is to reflect all parallel rays to one focus; and the accomplishment of this object is the great triumph of the optician's skill. A concave parabolic, or, more correctly, paraboloidal,† surface corresponds about its centre with a sphere of shorter radius, at its margin with one of longer radius, than the one that would most nearly fit its intermediate portion; and consequently the sphere may be made to approximate to a parabola by either deepening its centre, or flattening its edges; as will be apparent from considering the diagram, where a deepening of the curvature about B would so alter the direction of the reflected ray B I as to bring it down to H, or a flattening in the region of A would raise A H up to I. If this could be accomplished by a simple rotatory motion, there would be less difficulty; but the polish would be spoiled by becoming a succession of concentric rings: motions in other directions are requisite to prevent this, and the best mode of employing them becomes a complicated problem, which, however, has been frequently solved with great success. Fortunately the quantity to be removed is comparatively very small, amounting, according to Sir J. Herschel's computation, to only one 21,333rd part of an inch for the edge of a speculum of 48 inches in diameter and 40 feet focus—a striking incidental proof, by the way, of the extraordinary delicacy which these processes involve, and the corresponding care which they require. Different methods have been adopted by different artificers to produce the parabolic form, whether in metal, or in glass prepared according to the new invention, which has been frequently referred to in these pages, for the reception of a film of silver. The mode followed by one of the inventors, Steinheil, seems not to be known in this country: that pursued by the other, Léon Foucault, is fully described in his elaborate memoir on the production of silvered specula. It consists of applying by hand smaller secondary polishers of deeper curvatures to bore out, as it were, the central part of the mirror, or, in the case of very large apertures, attacking the margin also with flatter ones. Other methods are at present used by the amateurs in this country who have taken up this beautiful manufacture with so much spirit and perseverance. The degree of success already attained will be readily appreciated by those who know the quality of the tests which have been resorted to;

* The front view without a small speculum is sometimes so called, from the name of its inventor. In the Gregorian form, and that of Cassegrain, a compensation of errors between the two specula is practicable.

† The parabola is the curved line;—the paraboloid, the surface produced by its supposed revolution round an axis; just as a circle, by a similar revolution, may be conceived to produce a sphere.

and a few notices of their progress will form a suitable conclusion to the present remarks.

Professor Frankland, of the Royal Institution, some time back completed a silvered glass speculum of 6 or 7 inches aperture, which bears a power of 750 on the moon with scarcely any perceptible diminution of sharpness and no want of light. Mr. Bird, of Birmingham, has wrought a 12-inch glass mirror to such perfection that in its unsilvered state it is capable of dividing ζ Cancri, now an exceedingly close star, while his speculum of $8\frac{3}{4}$ inches will separate ϵ Arietis, 52 Arietis, η Orionis, or η Coronæ Borealis, elongate ω Leonis, and show occasionally the sixth star in the trapezium of Orion. Mr. With, of Hereford, has finished a speculum of about 6 inches, which separates ζ Orionis with an interval equalling the disc of the larger star; shows a good black division between the components of 170 P. VII (the little pair closely *s f* Procyon); and brings out the fifth star *in trapezio* as a steady object. The Rev. H. C. Key is also engaged upon two 12-inch glass discs, and devoting the greatest attention to the attainment of extreme perfection in the spherical figure, as he has already discovered a method of subsequently rendering it parabolic, which has been tested with complete success. He employs, in common with Messrs. Bird and With, a modification of the Earl of Rosse's polishing-machine.

DOUBLE STARS.

In the wide and tolerably bright region of the galaxy lying to the E. of *Orion*, which is occupied by part of Hevel's constellation *Monoceros*, we shall find two good objects. First, if we carry a line from λ in the head of *Orion* (No. 99) through *α*, or *Betelgeuse*, the large red star a little *s f* in the Giant's shoulder, it will point somewhat below the brightest of several small stars—

101. 8 *Monocerotis*. 12″·9. 23°·8. $5\frac{1}{2}$ and 8. Yellow and flushed blue. This beautiful pair, Smyth thinks, may perhaps be in orbital motion. It lies in a glorious low-power field.

If we now draw a line from *Sirius* to *α Orionis*, a little to the left of it, and some way below its centre, lies the *lucida* of the vicinity, which is—

102. 11 *Monocerotis*. 2″·8. 102°·3. 7 and 8. Pale white. The immediate neighbourhood of a third white $6\frac{1}{2}$ mag. star (which is properly 11), at 7″·2 and 130°·3 from the nearest of the pair, makes this a triple combination, called by Herschel I. "one of the most beautiful sights in the heavens." Notwithstanding the aspect of physical connexion so strongly impressed upon this group, no motion has as yet been detected in it: a singular fact, leading to some remarkable speculations.

Had we only a double system before us, it might have been supposed that the components had reached the opposite apparent ends of an orbit lying nearly in the plane of our sight, in which position the real motion being directed nearly towards or from the eye, becomes for a considerable time almost inappreciable. But this idea is contravened by the long interval since its discovery, which would surely ere now have effected some change of distance, and is completely overthrown by the combination of a third object, which would as surely not have remained apparently unmoved during the whole of that period from the same cause. It would seem, therefore, that we are obliged to suppose, either that these bodies are only in apparent and not actual proximity, or that they are not amenable to the law of gravitation, or that some peculiarity in their constitution modifies its influence. The first of these suppositions may be readily laid aside; the chances being inappreciably great against the position of three objects almost in a line behind one another, whose different degrees of brightness would so nearly compensate their different distances as to produce the effect which we see. The second ought not, if possible, to be admitted, as being contrary to the whole analogy of the known creation, and especially to instances in every part of the heavens in which systems of stars are found to be in motion in accordance with this, or at least some similar law. We are obliged, therefore, to fall back upon the third, as the more probable, hypothesis, and to explain this apparent immobility by inferring a condition in which gravity would act feebly, and motion would be in proportion slow. This might be met by the supposition of unusual remoteness between the components of the group, in which case, as they appear so close, they must be at an amazing distance from us, much exceeding that of the majority of such objects; or else, if their interval does not exceed an average limit, we may suppose the naturally-resulting rapidity of motion counteracted by deficiency in density or inferiority in magnitude. In these ideas there is nothing extravagant, for our own sun has a density only one-fourth of that of the earth; the huge globe of Saturn is so light that it would actually *float in water;* and a far higher attenuation is easily conceivable: diminutive size, on the other hand, might be compensated by greater intrinsic splendour without our detecting it, since, from extreme remoteness, we have never yet distinguished the real disc of any star, and magnitude and brilliancy have evidently no mutual dependence. In fact, there are reasons for supposing that the Apostle's expression, "one star differeth from another star in glory," though apparently employed by him merely as a popular illustration drawn from

their different aspect to our eyes, may be equally true as applied to their intrinsic splendour. None of these hypotheses, therefore, drive us upon any improbability, while they enlarge our ideas of the wonderful diversity, as well as magnificence, of the works of the Creator.

If we now cross the galaxy in an E. direction, till we reach a line down from *Polaris* through *Castor*, we find a beautiful first-magnitude star, *α Canis Minoris, Procyon*, introduced here as a pointer to a delicate pair, too small, otherwise, for our list, but so readily found from its splendid neighbour, and so especially valuable as a test-object, that it well deserves insertion. It lies a little way *s f* from *α*, in the same field with it under a moderate power, and is the brightest among many companions. It has been often referred to as "31 *Canis Minoris* (Bode)," having been so designated by that astronomer; but we shall give it Smyth's appellation:—

103. 170 P. VII. *Canis Minoris.* 1″·4. 132°·9. 7 and 8. White and ash-coloured. Secchi thinks this very pretty double star is in slow angular motion. I have seen the discs in contact with 144 on $3\frac{7}{10}$ inches; with 300 on my present $5\frac{1}{2}$ inches the division is about equal to one diameter of the smaller star. The remark in Herschel and South's catalogue (1821—1823) that 133, the usual observing power of the 5 feet equatorial, gave no suspicion of its being double, and 303 just separated the discs, would lead to the idea of a widened distance, which, however, the measures of Struve and Secchi do not confirm.

We now proceed to two objects which, from want of space, were obliged to be postponed last spring till they had advanced too far into the twilight. The first of them is a glorious double star—

104. *γ Leonis.* 2″·6. 103°·2 (1831·36). 2‴·8. 107°·2 (1843·18). 2 and 4. Bright orange and greenish yellow. Herschel I. called them white and reddish-white; and as his bias was in favour of ruddy tints, there is a suspicion of change since his day. This has been called the noblest pair above our horizon, for the grandest of all, *α Centauri*, both of 2nd mag., only begins to be visible in Egypt and conspicuous in the West Indies. It is an excellent test for small instruments. I have divided it well with a beautiful $2\frac{1}{4}$ inch glass by Bardou, of Paris, and Smyth found it within the reach of 2 inches. It is impossible to look upon these two golden suns without admiration, and we shall not be surprised to find that they form a binary system. Smyth's measures alone show this; but it is still more evident from Herschel I.'s angle, 83° 30′, in 1782, and the recent measures of Secchi, whose mean is 3″·047 and 108°·11 (1858·869). The motion, however, is slow,

and the period must be long; but, perhaps not, as formerly supposed, so much as 1000 years. This object may be found from the great star *Regulus* (*α Leonis*, the Lion's Heart), the brightest in a large tract E. of the Twins and Procyon. N. of Regulus, at a short distance, lies a 3rd mag. star, *η Leonis; n f* from this, at a still less distance, is *γ*, next after *α* the brightest in the vicinity. Regulus possesses some interest as marking very nearly the position of the ecliptic, or apparent path of the sun in the heavens, the star being only a few minutes above the N. limb of the sun on August 21 of the present year.

Our next is a more difficult object,—

105. *ι Leonis*. 2″·4. 90°·5 (1836·4). 2″·5. 81°·3 (1853·29). 4 and 7½. Pale yellow and light blue. This pair, missed by previous observers, and discovered by W. Struve at Dorpat, is no doubt a binary one; its continued retrogradation appears from Secchi, the mean of whose measures gives 2″·568 and 76°·38 (1856·263). Its beauty fully entitles it to a trial, but it is too close for a very small telescope. I have seen it well with $3\frac{7}{10}$ inches and power 144, 80 only just separating it. It will be caught as the nearest 4th mag. star *s p Denebola*, a 2nd mag. star in the Lion's tail, which is the most conspicuous to the E. of Regulus, but at a considerable distance, and lying nearly in the direction of Arcturus from the latter star.

OCCULTATIONS.

The following occultations will be conveniently visible:—April 2, B. A. C. 4006 (*i. e.* the star so numbered in the British Association Catalogue), 6 mag., from 11h. 25m. till 12h. 4m. 26th, *κ* Cancri, 5 mag., from 9h. 46m. till 10h. 54m. 29th, *e* Leonis, 5 mag., from 10h. 29m. till 11h. 28m.

DARK TRANSITS OF THE SATELLITES OF JUPITER.

Jupiter having now become very conspicuous in the S.E. sky, the dark transits of his satellites will again be objects of curiosity; and as the opposition of the planet takes place on the 12th, the reversion of the relative positions of the satellites and their shadows in the course of the month, and their very close proximity about the time of the opposition, will be noticed with much interest. The following transits are those most convenient for observation:—April 3rd. The shadow of II. leaves the disc at 9h. 52m., followed by the satellite at 10h. 14m. 4th. The shadow of I. enters at 11h. 26m., the satellite following at 11h. 38m. 6th. The shadow of I. passes off at 8h. 8m., the satellite at 8h. 16m.; the shadow of III. at 9h. 28m., III. itself at 9h. 50m.: thus previously to 8h. 8m.

two satellites with their respective shadows will be on the disc at the same time. 10th. The shadow of II. is on Jupiter from 9h. 55m. till 12h. 26m.; the satellite from 10h. 3m. till 12h. 28m. 13th. The opposition being past, and the shadows transferred to the other side, I. will be in transit from 7h. 48m. till 10h.; its shadow from 7h. 49m. till 10h. 2m.: at 10h. 54m. and 10h. 59m. the shadow of III. and III. itself respectively enter. 20th. The ingress of I. is at 9h. 32m., of its shadow, at 9h. 43m.; their respective egresses at 11h. 44m. and 11h. 56m. 27th. I. will enter at 11h. 17m., followed by its shadow at 11h. 37m.

ANALYSIS OF MIXED FABRICS.

The interesting researches of M. Persoz, jun., on the power of a strong solution of chloride of zinc to dissolve silk, affords the means by which a real analysis of a mixed fabric of silk, cotton, and wool may be made.

To dissolve silk, a strong solution of chloride of zinc should be first boiled with excess of oxide of zinc, and the clear solution should be afterwards separated either by decanting or by filtering through a funnel stopped with asbestos. Silk boiled in this solution readily dissolves, and if a mixed fabric of silk, cotton, and wool be so treated, the silk only is dissolved out. If the residue of the fabric is then removed, carefully washed so as to get rid of all adhering chloride of zinc, and afterwards boiled in a strong solution of caustic soda or potash, the wool is dissolved, when the remaining cotton, after having been washed from the potash solution, can be recognized under the microscope.

The properties of the solution of silk are strikingly shown if the chloride of zinc is got rid of by dialysing. This may be perfectly accomplished if the solution is weak, when a golden yellow varnish of dissolved silk remains in the dialyser; this is viscid and may be drawn out into threads; on evaporation it leaves the silk in a somewhat altered form, the tenacity being much lessened.

If, on the other hand, a concentrated solution is dialysed, the whole of the chloride is not got rid of, but towards the conclusion of the operation the silk solution in the dialyser increases very much in size by the absorption of water through the parchment paper, sometimes even to such an extent as to fill up the vessel, and eventually becomes a ropy magma, or tenacious semi-solid mass.

This mode of separating the different tissues in mixed fabrics offers an interesting contrast to that adopted by Mr. Ward, in which the wool is destroyed by a heat just sufficient to char it, leaving the cotton or linen in an uninjured state.

FLAME-COLOURS.

Although a spectroscope is requisite in order to recognize with certainty the various metals in a mixture by means of the systems of coloured rays characteristic of each metal when burning, yet some very instructive and beautiful effects may be obtained with scarcely any apparatus at all. For this purpose it has been suggested* that the chlorates of the different metals should be used. If inside the edge of the flame of a small spirit-lamp, or, better, of a Bunsen gas-burner, a fused bead of chlorate of potash be held in a loop of platinum wire, after a second or two there takes place an explosive flash of violet flame, intense and beautiful; while chlorate of soda gives the well-known yellow light with peculiar brilliancy: but it is, perhaps, with chlorate of baryta that the most striking phenomenon is produced. In this instance it is sufficient to bring a crystal of the salt (which may be readily obtained in commerce) in contact with the flame, when a series of decrepitations occur, accompanied by bursts of the characteristic green light. A pretty effect is seen when chlorate of baryta is introduced into one side of a flame, and chlorate of strontia on the other. The chlorates of lithia, strontia, and lime offer, when thus ignited, a spectacle of great splendour; and if a spectroscope be employed, the blue bands of lithia are clearly seen, although with its other salts the high temperature of the electric arc alone developes them. Chlorate of copper is another compound, the violet-blue flame of which is unusually brilliant when shown as we have described. But it is quite possible to dispense with the Bunsen gas-burner or spirit-lamp, and even with the platinum wire, and yet to obtain results as striking, if not more so. For this purpose some *gun-paper*, made in the same way as gun-cotton, is to be soaked in solutions of the various chlorates mentioned above, dried with care, and *kept* dry. A good gun-paper for the purpose is prepared by soaking strips of Swedish filtering-paper for ten minutes in a mixture of four parts of oil of vitriol with five parts of strong nitric acid, both by measure: the strips when taken out of the acid should be washed first with cold, and then with hot rain or distilled water, till the washings

* *Chemical News.* A. H. Church, Dec. 24th, 1859, and W. Crookes, April 26th, 1862.

are no longer sour to the taste. The solutions of the metallic salts need not be very strong; but if they are warm, the strips of gun-paper will be more easily and completely saturated with them. Since some of the chlorates attract moisture from the air, it is better to dry the papers prepared with these compounds before the fire carefully previous to lighting them. They are shown to best advantage when a strip is loosely crumpled up into a pellet, lighted quickly at one corner, and thrown up into the air against a dark background. They leave, after burning, if properly prepared, no ash whatever.

The flame of copper is well seen even with the chloride of that metal, while paper soaked in nitrate of potash shows the flame better than if the chlorate be used. Gun-paper prepared with a very weak solution of chloride or chlorate of thallium shows the characteristic spring-green flame of that metal with great distinctness.

Chlorate of baryta, being an article of commerce, may be employed for the preparation of the other chlorates, it being necessary merely to add to this salt in solution an exactly equivalent quantity of the *sulphate* or *carbonate* of the metal whose chlorate is desired. For instance, in order to make chlorate of copper, 15·1 grains of chlorate of baryta being dissolved in hot distilled water, a boiling solution containing 12·5 grains of pure crystallized sulphate of copper is to be added to it. Insoluble white sulphate of baryta falls, while the solution, filtered and evaporated, yields the new chlorate in crystals.

In some cases, by means of coloured glasses and coloured liquids, interposed between the flame and the eye, it is easy, when two metals are burning together, to shut off the rays due to one metal, and permit those due to the other to reach the observer. If, for example, a mixed potassium and sodium flame be viewed through a piece of deep cobalt-blue glass, or through a flat bottle filled with water rather deeply tinted with aniline purple (mauve), the violet potassium flame is seen, while the far more intense yellow of the sodium spectrum is totally obscured.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

ROYAL SOCIETY.—*Feb.* 19.

The New Metal Thallium.—A second memoir on this singular metal, by its discoverer, Mr. William Crookes, was read by the Secretary. The paper was a most voluminous and elaborate one, treating in an exhaustive manner of the sources, mode of preparation and purification, and of the chemical and physical characters of this widely-diffused element. When we state that nearly two hours were occupied in reading the more important portions only of the memoir, it will be understood how impossible it would be to give here any adequate idea of the immense mass of results which it recorded. At the conclusion of the evening a high tribute was paid by Professors Miller and Williamson and by Dr. Stenhouse to Mr. Crookes, for his acuteness, zeal, and industry in discovering, and so thoroughly investigating, this unique metal. We gleaned the following interesting information from the paper read:—The specific gravity of thallium varies from 11·81 to 11·91; it melts at 550° F., and may be most readily welded. If the formula Tl O, SO_3 be assigned to its sulphate, the atomic weight of the metal approaches the number 203. The colour of metallic thallium, when freshly cut, is dull white, it has neither the brilliancy of silver nor the blue tint of lead. It tarnishes rapidly, and a straw-yellow colour almost immediately appears on the freshly-cut surface. The oxide thus formed is alkaline and caustic to the taste, and is far more soluble in water than the corresponding oxides, also alkaline, of silver and lead. Thallium is very strongly diamagnetic, approaching bismuth in this particular: the behaviour of its solution when electrolysed ranges the metal by the side of cadmium. Its effects, when alloyed with other metals, are generally well marked. Half a per cent. of thallium renders copper brittle, although its alloy with tin is malleable. The remarkably simple spectrum of this metal has been made the subject of further examination both by Mr. Crookes and Professor W. A. Miller. In the exalted temperature of the electric arc, the single green line proper to thallium when burnt in a Bunsen's gas jet, is complicated by the appearance of several blue, green, and other lines; but no means have yet been found sufficient to resolve the extremely narrow green line first seen, which approaches, but does not coincide with, the line δ of the barium spectrum. The flame of thallium, like that of sodium, is opaque to its own light. This phenomenon may be beautifully displayed by placing a small thallium flame in front of a large one, the latter containing, in addition, a quantity of lithium insufficient to neutralize its proper colour. Instead of a *black* border to the smaller flame, a *crimson* one appears, since the lithium rays are alone able to traverse the thallium flame in front. By means of the

spectroscope one 5-millionth of a grain of thallium may be detected. Since the reading of Mr. Crookes' paper the specific heat of thallium has been published by Regnault, who describes it as being ·03355.

ETHNOLOGICAL SOCIETY.—*Feb.* 17.

"On the Origin of the Gypsies," by J. Crawfurd, Esq.—The origin of the persons calling themselves Egyptians, or Gypsies, is a subject of great curiosity and etymological import. Their first appearance in Europe was coeval with the discovery of the New World and the new passage to the Indies, but no one thought of ascribing to them a Hindu origin, and this hypothesis, the truth of which the author now proposed to examine, was of a very recent date. Their Hindu origin has of late years received general credence; the arguments for it consist in the physical form of the people, in their language, and in the history of their migration. The conclusion the author came to was, that the gypsies, when above four centuries ago they first appeared in Western Europe, were already composed of a mixture of many different races, and that the present gypsies are still more mongrel. In the Asiatic portion of their lineage there is probably a small proportion of Hindu blood. Strictly speaking, they are not more Hindus in lineage than they are Persians, Turks, Wallachians, or Europeans, for they are a mixture of all these, and that in proportions impossible to be ascertained.

GEOGRAPHICAL SOCIETY.—*Feb.* 23.

On the Subglacial Springs of Greenland.—Dr. Binks described the peculiar character of the glaciers of Greenland, regarding them as frozen mountain rivers, carrying the drainage water of 200,000 square miles into Davis Straits and Baffin's Bay. The upper portion of these torrents only is frozen, and forms the slowly-moving glacier; the lower flows on rapidly through the channels underneath the ice. It is noticed that where the glacier reaches the sea, large springs appear to issue from the bottom in front of the outer edge of the ice, the water, which is brackish, is much agitated, and sea-birds are to be observed diving after the food brought down by the current. Dr. Binks maintains that these phenomena can only be explained on the supposition that the glaciers are mountain torrents, frozen on the upper surface. Sir Roderick Murchison regarded the investigations as of great importance, and stated that they threw light upon the former condition of the northern portion of Scotland, which must have closely resembled the present actual condition of Greenland.

NOTES AND MEMORANDA.

The Eosaurus Acadianus and Anthracosaurus Russelli.—The *Quarterly Journal of the Geological Society*, Feb. 1863, contains an abridgment of a paper by O. C. Marsh, Esq., M.A., "On the Remains of a New Enaliosaurian (or great Sea Lizard) discovered in the Coal Formation of Nova Scotia, at South Joggins." It appears to have been of great size, air-breathing, carnivorous, and adapted for rapid swimming. If the view taken of these remains should be confirmed, they will supply additional evidence to show that a high form of reptile life existed at a period when those who found their theories upon negative evidence very recently imagined that no reptile of any kind had made its appearance on our globe. In the same journal will be found Professor Huxley's description of the *Anthracosaurus Russelli*, a new Labyrinthrodont from the Lanarkshire coal-field. He says, "Of the unquestionable Labyrinthodonts which occur in the carboniferous rocks, *Anthracosaurus* is the only genus, regarding the vertebral column and ribs, of which there is any information, and the description and comparisons which I have given, seem to me to necessitate the conclusion that, side by side with the Archegosaurian type, the Mastodonsaurian type of vertebrate organization, hitherto known only to occur in the Trias, was well developed in the *Anthracosaurus* of the Scotch coal-field."

Secchi on Star Spectra.—We mentioned in our March number that M. Secchi had examined the spectra afforded by various stars, and in the *Astronomische Nachrichten*, No. 1405, we find a letter from him on this subject, accompanied with diagrams. He observes that his attention has been chiefly directed to the most brilliant stars, and that their scintillations occasion considerable difficulty. He found α Orionis the most remarkable, and states, "this spectrum is composed of a multitude of separate portions, somewhat like that of the electric light. The ray D of the solar spectrum corresponds exactly with a tolerably broad obscure space . . . . After Orion comes the spectrum of Aldebaran, which likewise exhibits many discontinuities, but not in equal number, nor of so great an extent. The ray D is, however, visible and sure. Then Pollux exhibits bands less easy to perceive, but nevertheless noticeable in the least refrangible part. The preceding are coloured stars, and the white stars that I have examined present notable interruptions, especially in the blue (like the others) and in the violet, but the interruptions are rarer in the less refrangible parts, except the red. Sirius and Rigel have a large band at the limit of the blue and the green, with two others, one in the blue and one in the violet. Ray No. 11 is found in all the stars and in the sun. May it not have its origin in the terrestrial atmosphere? . . . Besides the rays, we remarked a different intensity of the colours in different positions of the spectrum. These diversities in intensity are enormous, particularly in α Orionis, and surpass the finest effects in the spectra of flames . . . We see in general that the most coloured stars have the most gaps in their rays. This, I think, confirms the opinion that our sun is a yellow star. . . . The limits of the colour depend much upon the intensity of the light. The red commences at nearly the same place in all the stars, but the violet exhibits great variableness, to which the state of the atmosphere contributes a good deal." Upon this subject the Rev. T. W. Webb remarks:—"The Astronomer Royal has completed an apparatus for the purpose of examining the dark lines in the spectra of stars with the great equatorial at Greenwich. This very curious subject was first entered upon by Frauenhofer, from whose experiments it would be inferred that the light of some of the fixed stars is essentially different in constitution from that of our sun. It has since been several times taken up, but not carried out to any very satisfactory conclusion: we will hope that its full development may be reserved for our national observatory and for its able director."

Dark Stars.—The Rev. T. W. Webb observes:—"When close attention began to be paid to the 'proper motions' by which a great proportion of the fixed (or rather *un*fixed) stars are slowly drifting from their places, it was soon found that the movements of the brilliant stars Sirius and Procyon were such as to deviate considerably from the sensibly straight course pursued by the rest, and a

suspicion was excited in the master mind of Bessel that the irregularity was the indication of a marvellous physical fact—the existence of invisible bodies grouped into binary systems with those bright suns, and of such great magnitude, or at least density, as to compel them to describe orbits, visible even at the distance of our earth. It is remarkable that more than a century ago the German mathematician, Lambert, suggested the possible existence of great non-luminous bodies in the universe; and now at length the Council of the Astronomical Society have stated that from the researches of W. Stafford, of Harvard College, North America, and Herr Auwers, of Königsberg, it 'appears established as an astronomical fact, that the heretofore anomalous motions of *Sirius* and *Procyon*, both in Right Ascension and in Declination, are explained and satisfied by the existence of invisible masses, round which these stars may be conceived to revolve, Sirius in fifty, and Procyon in forty years.' Such is also the opinion of the Astronomer Royal, Sir J. Herschel, and Professor Bond. No reference has been made to the minute attendant of Sirius, discovered by Alvan Clark, which Dr. Peters seemed disposed to accept as the physical companion, and as to the distance of which there seems to be some unexplained difficulty." (See *Intellectual Observer*, v. 401. vi. 482.)

Orbit of Comet, 1862.—The orbit of the comet so conspicuous in August of last year (Comet II. 1862) is certainly elliptical, and from a careful discussion by Herr Oppolzen of the Vienna Observatory, the period appears to be about 142 years. The other three comets of the year give no indication of a period. —T. W W.

Smith and Beck's Quarter and Lieberkuhn.—This new object-glass has an angular aperture of 75°, which adapts it for binocular use, and allows a convenient distance between the front combination and the object. The lieberkuhn, which is removable, affords abundant light with the first or second eye-piece, and enables large diatoms, such as Arachnoidiscus or Aulacodiscus, to be viewed in a very splendid and effective way. Many which seem flat by ordinary illumination have their curved surfaces distinctly shown by this method. It works well upon many preparations of insects, thin sections of bone, etc., and is well suited for employment with the parabolic illuminator. In several cases we found that the parabola and the lieberkuhn could be used together with great advantage.

Crouch's Binocular Microscope and Cabinet for Slides.—Messrs. H. and W. Crouch have introduced a new binocular microscope to meet the demand for an instrument of moderate price and sufficient excellence for ordinary purposes. The novelty consists in a moveable stage, intended, like the excellent one devised by Mr. Pillischer, to act as a substitute for the superior, but necessarily expensive, screw movements. The object-carrier, furnished with two spring clips, is attached to a sort of chain composed of three flat links joined to each other by screws, so as to produce a moderate stiffness of motion. The lowest link is screwed to the stage a little out of the centre. If the object-holder is pushed upwards, the links are straightened, while, if it is pushed downwards, they are bent into elbow-joint angles, and lateral motion is easily effected. A few minutes' practice will enable any one to work this arrangement so as to be useful with a low power, or with a quarter. The prism of this instrument performs well, as do the cheap series of glasses with moderate angles of aperture. We tried a number of objects with the two-inch and one-inch powers, and can state that few students will desire a greater perfection or refinement of performance. Messrs. Crouch undertake to supply objectives of high quality for those who wish them, but we congratulate them, and other successful makers of cheap instruments, on the good they are accomplishing, as it is by such means only that the taste for microscopic studies can be extended, and students trained so as to be able to employ with advantage the exquisitely perfect instruments and glasses that our best makers can produce. The new microscopic cabinet is made of ornamental white deal, French polished. It presents a neat and pretty appearance, and the material permits a great reduction in price. The drawers hold one thousand objects, lying flat, and they are furnished with ivory knobs and ground-glass labels. The workmanship is very good.

Irritability of Plants.—Professor J. Cohn, after elaborate experiments on the irritability of plants, has arrived at the conclusion that they possess a low

form of sensation similar to that manifested by the lower animals, in which neither muscular nor nervous system can be traced. Dr. Arlidge, in an abstract of these investigations (*Annals of Natural History*), thus cites Cohn's views:—"On applying flame to the leaflet in the compound leaf of *Mimosa pudica*, it is not only that particular leaflet that is affected—for if so, it might be fairly attributable to the direct effect of heat—but all other leaflets, and the entire leaf, including its attachment to the stem, are similarly affected, and collapse; and, what is more, the direction of the propagation of the impulse varies according to the point at which it impinges. Indeed, it is impossible to reduce these movements to the level of mechanical results." He considers that the vascular bundles propagate the external excitation, and that the "phenomena of contractility depend upon a muscular tissue." In another passage it is stated that "there is a difficulty in believing that, in possessing the faculties of sensation and motion, the animal kingdom, including its lowest and most simple representatives, partakes of vital endowments entirely denied to plants, for the sole reason of their being plants."

Gassiot on Electrical Discharges.—The *Proceedings of the Royal Society*, No. 53, contain a paper by M. Gassiot on the stratified appearance of electrical discharges, and details of numerous experiments made with various vacuum tubes, and a battery of 3360 cells charged with salt and water. He finds that under certain conditions the discharge is continuous, and in others intermittent, or appear so when viewed in a revolving or rotating mirror. The intermittence is produced by any resistance introduced into the circuit. The discharge will not pass through a perfect vacuum, the presence of a certain quantity of matter being indispensable. The striæ in the discharge can be controlled, their number increased or reduced, and their places altered by the introduction of a measurable amount of resistance into the circuit. M. Gassiot asks, "May not the dark bands be the nodes of undulations arising from similar impulses proceeding from positive and negative discharges? Or can the luminous stratifications which we obtain in a closed circuit of the secondary coil of an induction apparatus, and in the circuit of the voltaic battery, be the representation of pulsations which pass along the wire of the former, and through the battery of the latter—impulses possibly generated by the action of the discharge along the wires?"

Photographs of the Moon.—Messrs. Smith and Beck having purchased Mr. De la Rue's admirable negatives, have published a series of lunar views, which will prove of great use to those who have the means of studying our satellite through a telescope, and afford no slight compensation to those who must content themselves with pictorial representations. The photographs are numbered from one to twelve, the first giving the crescent when six days old, and the remainder tracing the lunar progress through the waxing and waning periods to the $23\frac{1}{2}$ day. The large eighteen-inch plates are superb specimens of astronomic photography, and not less excellent is the small portable series of the carte de visite size, and arranged in pocket-book form. None of them display to advantage the grand mountain peaks and chasms standing out in advance, as it were, of the body of the moon, which constitute such striking spectacles in a good telescope, used at appropriate times; but nearly every mountain or object of importance may be distinctly seen in one or other of the views, which exhibit a minuteness of perfection that would scarcely have been deemed possible. They are very superior to any lunar maps that have ever been published, and will be found extremely valuable accompaniments to the series of papers on the moon which Mr. Webb commenced in a former number, and will continue at convenient times. The public cannot fail to appreciate these illustrations of lunar scenery, both for their artistic beauty and scientific use, and we hope they will be followed by the publication of further specimens of Mr. De la Rue's photographic skill. We should add that the explanatory pamphlet issued with the views forms an excellent guide to all the principal objects.

Heisby & Co., photo.

Sculptured Monolith Portal at Tia Huanaco, Bolivia.

THE INTELLECTUAL OBSERVER.

MAY, 1863.

THE PRE-INCARIAL RUINS OF TIA HUANACO, IN BOLIVIA, FORMERLY UPPER PERU.

BY WM. BOLLAERT, F.R.G.S.

(With a Coloured Plate.)

Two routes, both from the shores of the Pacific, may be recommended to the traveller who desires to explore these most ancient monuments. One route is from Arica by railway to Tacna, then by mule up the western slopes of the Cordillera, and across it to the Desaguadero, or outlet of Lake Titicaca, from which river the ruins of Tia Huanaco are distant twenty-seven miles. However, a far more interesting road, though longer, is from Lima, when the traveller would have the opportunity of visiting the temple and city of Pachacamac on the coast, the work of a nation conquered by the later Incas. Ascending the Cordillera, Incarial ruins will be met with continually; the native suspension bridge of ropes over the deep chasm in which runs the river Apurimac will be crossed, after which Cuzco will be entered, still glorious in its ruins of edifices belonging to the times of the Incas; but unlike the very much more ancient, which I propose to call the Pre-Incarial, remains of Tia Huanaco, the work of a period we know nothing of, either historically or traditionally.

Going from Cuzco south, until the great basin of Lake Titicaca is reached, the country is inhabited by Quichua, or, as they are sometimes called, Inca Indians; but around Lake Titicaca, its islands, and vicinity, live the Aymará people.*

* Markham, in his *Travels in Peru and India*, while superintending the collection of Chinchona plants and seeds in South America, and their introduction into India says, that according to Calancha (1653), a rock called Titicaca gave its name to the island and lake; *titi* being the Aymará for a cat, and *caca* for a rock, for on this rock a cat (wild) is said to have sat with fire starting from its eyes. In Quichua *titi* means lead. On this rock, which is at the west-end of the island of Titicaca, there was an altar, where the Aymarás adored the sun, and near it were

Near to the south end of the lake are the extraordinary monuments about to be described. They are within sight of the road from the Desaguadero to the city of La Paz, twelve miles from the southern end of Lake Titicaca, in 16° 42′ south, 68° 42′ west, and 12,930 feet above the level of the sea. At the period of the conquest some of the walls, we are told, were washed by the waters of Lake Titicaca; these waters are now some twelve miles distant, and 135 feet below the base of the ruins.

The present hamlet of Tia Huanaco, containing about a hundred and twenty habitations—the greater number now deserted—is within sight of this interesting spot, in a north-west direction.

The existence of such a collection of stone-remains at an elevation of nearly 13,000 feet above the level of the sea is rather surprising; and from the writer's personal experience of the neighbouring *puna* region (Andean tableland) of Tarapacá, such an elevation is not propitious to animal or vegetable life, and we wonder, and ask for an explanation, why this seat of an ancient and peculiar civilization should have been placed at such a height. It may be a subject for speculation and inquiry as to what was then the nature of the climate and soil to have produced sustenance for the builders of these monuments. They are sometimes, but erroneously, called Casas, or houses of the Inca.

DESCRIPTION OF THE RUINS.

I. The Great Mound (for there is another artificial one near to it) is at present of a hill-like form, of 918 feet in length, with a breadth of about 400 feet, 100 to 120 feet in height, and some accounts state it to be built on a solid or stone foundation.

Early Spanish writers called it a pyramidal structure, and from the large quantity of stone ruins on it, they supposed that there might have been a fortress and buildings thereon, as well as a temple on its summit. The base of the mound is surrounded by large stones perfectly worked, a number of which have been taken away, especially to build the present church of Tia Huanaco.

II. The pilasters are also called pillars, obelisks, and porticoes. Castelnau observes that some are worked, others are in the rough, and are of a hard sandstone and green granite; they are not square, but squared, and it has been thought that some of them may have served as a gallery to a large building which

three idols joined in one, called *Apu Tuti* (the chief sun), *Churip Tuti* (the son's sun), and *Tutip Hauqui* (brother of the sun).

It seems certain that, from emblems found carved upon the ruins and from tradition, the worship of the sun and moon was established amongst the Aymarás for ages before the conquest of their country by the Incas of Cuzco.

once may have existed behind them. They are from eighteen to twenty-one feet in length, some three to four feet being in the ground, and several "métres" apart (the métre is 3·2809 English feet). A range of these is seen placed round the great mound. In a drawing in D'Orbigny, and in the recently-taken photograph by Helsby and Co., of Valparaiso and Liverpool, there is the appearance as if horizontal pieces had connected them, by being let in on the top of the pilasters; if so, what a magnificent Peruvian Stonehenge! A height of eighteen to twenty feet would give a width of four feet by two and a-half to three feet thick.

III. Remains of large slabs of worked stone, supposed to have been a hall of justice. D'Orbigny says there are three, and composed respectively of hard sandstone, trachyte, and basalt, and that some of the slabs are joined by metal clamps. Rivero and Tschudi observe that each slab has three seats cut out; and that numberless pieces of stone of all sizes, wrought into square, cruciform, and triangular figures, and many of them grooved, as if for windows and doors, lie about there; some have been united by metal clamps, the metal having been run into cavities made for that purpose. Castelnau speaks of the slabs as four sets of seats, each being about thirty-six feet square, and five feet thick. They are to the north-west of the mounds.

In some drawings of these slabs they look as if of a more recent date than the pilasters, portals, and other remains.

According to Castelnau there is in advance of the slabs a series of stones showing admirable workmanship, and he says that we wonder at the means which were employed, or by what sort of tools. The present Indians say that the original builders had a plan of softening stone by the application of certain herbs!

IV. The broken sculptured monolith portal is N.E. of the seats of justice. Thanks to Messrs. Helsby, we have now a photograph of this most interesting monument. (See drawing.) In the photograph the portal is seen broken into two unequal portions and partially buried in the ground. Mr. Pentland informs me that it has sunk much (or rather earth has collected round its base) since he saw it in 1834; he also tells me attempts have been made to break it up for mill-stones. It would appear that it stood on its own solid foundation. D'Orbigny gives the following dimensions for this portal:—Above the ground it is 10 feet; in width, 13 feet 3 inches; of one block of hard trachytic rock; the doorway 6 feet high. The eastern face has three lines of sculptured figures in alto-relief of men, and figures of men with bird's heads; each line has sixteen figures, and in the centre a larger sculptured human figure; the west face

has no sculptures. The two niches below (Castelnau calls them "cavités transversales) appear to have had doors with copper hinges. D'Orbigny thinks the figures with human heads denote kings, those with the condors' heads "savage chiefs," or the condors may be considered as the sun's messengers, or attendants on the kings. The figures with human and bird's heads look towards the principal central figure. All the figures are highly ornamented with heads of birds; those with heads of men have fourteen heads of birds, and three more on the staff; the bird-headed figures have seventeen heads of birds, and three on the staff.

In vol. ii. p. 22, *Viage á las dos Americas*, there is a drawing of this portal. It is given entire, and three lines of human figures are drawn, which is incorrect, for the figures of the centre line have heads of birds.

If this portal stands on its own solid foundation, it may have been cut out of a block of stone of some 600 tons.

Ere the builders of Tia Huanaco could have arrived at such sculpture as is seen on the portal, a long period of time must have elapsed. The alto-reliefs on the portal and the work on the statues are something wonderful, when we consider that the sculptors, it is generally believed, had no tools of iron.

Dr. Manuel Guerra, formerly Prefect of La Paz, tells me that at his silver mines of Kimsachaca, eight miles from the ruins, there is a monolith portal, which has been taken there from Tia Huanaco.

V. The colossal stone idols appear to have stood on the north side of the mound. Gibbon, in Part ii. of *Exploration of the Amazons*, in 1851, says that at the gateway of the church of Tia Huanaco were standing two heavy stone idols, with their hands crossed. Castelnau mentions that two great idols, male and female, stand now before the cemetery of the village, and crowned with a sort of turban. He also adverts to another colossal head, and a lizard carved on blocks of stone. The lizard, after the condor, seems to have been a favourite device of the ancient Aymarás. Rivero and Tschudi give the following dimensions of one, most probably of the large colossal heads:—From the chin to upper part, 3 feet 6 inches; in diameter, 2 feet 7 inches. Say this was one-fifth of its height, it would give about 18 feet high and 4 feet in diameter. D'Orbigny tells us that they are of basalt, covered with sculptures in bas reliefs. There are human figures with fish or lizard-like tails on the head. There are eight human figures in front on the neck; the hands are very small, and just below the neck; an upturned moustache-looking ornament; large eyes, with apparently three smaller eyes below each eye; long downward-curved nose; and heads of birds like

the condors. Old Spanish writers describe these statues as having robes touching the ground, with their "tocados" or ornamented head-dress, the whole very much worn by time, which proved their great antiquity. Near to one of these idols some gold was found by the first Spaniards.

According to Garcilasso, between the pilasters and the wall that surrounded the great mound there were stone statues of men and women, as natural as life; some with cups in their hands drinking; others seated and standing; others as if passing a stream, which ran through the edifice: there were other statues of women with children in their laps, on their backs, and many other ways.

VI. A cyclopean wall of stone appears to have encompassed the great mound inside a range of pilasters. Acosta measured a block of stone of this wall, of 30 feet in length, 18 feet in width, and 6 feet thick; this Linton, in his *Colossal Vestiges of the Older Nations*, calculates at 200 tons. (However, some of the stones in the fortress at Cuzco, of Incarial work, are 50 feet in length, 22 feet broad, and 6 feet thick. Such masses of stone would weigh about 1000 tons.)

This may be the wall that was washed by the waters of Lake Titicaca, when Cieza de Leon was there, somewhat before 1550. He was born in 1517, lived seventeen years in America, and died 1560.

VII. Cieza de Leon is the first to speak of the monolith building, and if we can credit what is said of it by the Cura Alcobaza, a friend of Garcilasso's, this must have been one of the most wonderful monoliths known. Cieza says it is "An edifice the walls of which only remain, some of the stones much decayed by time."

Alcobaza wrote to Garcilasso that it consisted of a square court of 15 brazas (the braza is equal to a fathom or six feet), equal to 90 feet, and its walls two estados, or 12 feet high. On one side of the square court was a hall 45 feet long and 22 feet broad, the walls 9 inches thick, covered in imitation of a straw thatch, which is of stone (like that of the Temple of the Sun at Cuzco); the said court, with its walls, pavement, hall, stone thatch, portals, and thresholds of two doors belonging to the hall, and another door of the court-yard, *all this is of one mass of stone only*. The Indians told Alcobaza that this building had been dedicated to the Maker of the Universe.

Our elements for calculation are, a court-yard 90 feet square, its walls 12 feet high and 9 inches thick. The hall is 45 feet in length and 22 feet broad. If the whole of this was cut out of a solid body, such a mass could not have been less than a square of 90 feet, by 12 feet thick. Now if we take the cubic foot of this sort of stone at 200 lbs., and multiply the

area of one side by one edge, we shall get at a result, namely—a monolith of 8,678 tons!

Linton gives for the weight of the temple of Latona, at Buto, in the delta of the Nile, 5,000 tons; but this temple dedicated to the Maker of the Universe at Tia Huanaco was of superior magnitude by 3,678 tons.

It strikes me that this monolith building may have stood to the north of the great mound, and not far from it, inside the range of pilasters in which stands the sculptured monolith portal, and on the square spot in front of the mound, as seen in Plate IX. in D'Orbigny.

VIII. Old writers speak of the very large edifices, palaces, and temples of stone, of 656 and 328 feet in length, east and west, with their angular colossal columns, which probably mean the pilasters; in particular of a palace built of large blocks of stone, some of them 28 feet in length, over 13 feet in width, and over 6½ feet thick. D'Orbigny says that the palaces were to the east of the mound. The portals, or rather the door-ways, were perpendicular, and not like the Incarial, which inclined inwards towards the top.

Castelnau states that there are some subterranean canals amongst the ruins.

Rivero and Tschudi allude to very large masses of stone, so cut, that, when resting on each other, their junction formed a channel; these were examined by Don Manuel Guerra in 1846, when excavating here: he found some idols, one was three and a-half yards in length and half a yard in width; also some sculptured masses of large dimensions which have served to make stones for grinding chocolate.

D'Orbigny speaks of a figure like a sphinx, which, I should think, is the side ornament of a door; of figures like jaguars with the mouth open, and a hole drilled through the sides; and of animals of stone with holes cut in them, as if used for lamps, or rather for holding offerings. Castelnau notices a very large salamander in stone, and a colossal head, on the road before he got to the ruins, coming from La Paz.

The last visitors to the ruins of Tia Huanaco, who took an interest in them, were Mr. Helsby and his assistant in 1857, and to Mr. W. G. Helsby, of Liverpool,* I am much obliged for two photographs taken from daguerreotypes. One is a view of some of the pilasters, nine in number; the other is a view of the monolithic portal, now broken, said to have been split by lightning. (See drawing.) They found the surface of the mound covered with the remains of masonry, some with circular

* Carte de visite size views of the ruins of Tia Huanaco, as well as many others connected with South America, may be procured from Mr. W. G. Helsby, Church Street, Liverpool.

grooves. There was also a small stone portal upright, of some eight feet in height; it formerly lay on the ground, when the people of La Paz tried, but failed, to take it away to their city. Mr. Helsby had much difficulty in getting the Indian guide to sit on a stone by the side of the broken portal whilst he was operating; and when the Indian saw his likeness on the plate, he took to his heels and ran off. All they found there was a small copper object like a candle extinguisher, and a double-headed stone hammer.

I have been informed by Mr. Pentland that he made drawings and a plan of the ruins of Tia Huanaco, but these and his observations are still in MS.

He likewise told me that a gentleman, named John Bowring, visited Lake Titicaca and the ruins about 1834, and made drawings, supplying copies to D'Orbigny. On reference to the *Comptes Rendus*, 1839, p. 584, there is a letter from Mr. Pentland on the priority of Bowring as having surveyed the Lake Titicaca and made other investigations in that region.

Near to the ruins are two square towers like tombs, of Colla or old Aymará work. There are remains also of an Incarial palace, which may have been built by Mayta Capac, the IVth Inca, or by his son Yupanqui. Mayta Capac reigned thirty years, dying about 1156 A.D. He conquered the Collas, and being here when he received news, brought in great haste by a Chasqui or foot messenger, is said to have exclaimed, "Tia" or "Tiai Huanaco," which in the Quichua language means, "Rest or sit thou fleet as the Huanaco." It is asserted that this Inca built a wall thirty miles in length, extending from the Cordillera to Lake Titicaca.

There are vague traditions that Tia Huanaco was built by white and bearded men! that the city was reared in a single night by an invisible hand, that it was never finished! that it was destroyed, and the inhabitants turned to stone for having stoned a man to death who passed that way! also for having refused hospitality to Manco Capac!

Another is, that after the waters of the deluge had subsided, there appeared a Being who divided the country into four parts, giving them respectively to Manco Capac, Colla, Tocay, and Pinahua.

We, however, know that Mayta Capac came south from Cuzco, conquered the Collas (mountaineers), or Aymarás, and was in all probability the first Inca to behold the ruins of Tia Huanaco.

Lorente, the author of a recent *Historia del Peru*, alludes to a tradition that a king named Huyasutus built Tia Huanaco, and that its ancient name was Chuachua.

A Bolivian friend of mine tells me that "Chua Chua means

clear water, in Aymará." We are informed that a stream of water ran on each side of the mound; if so, they probably also ran through the city, and Chua Chua may mean the City of clear waters. These waters would be, most probably, clear and sweet compared with the generally brackish waters of Lake Titicaca, which came up to the walls of the place.

Then, as to the meaning of Huyusutus, the same friend informs me that *Huyu* means a hall. Can we say the halls, palaces, or city of the chief or King Sutu or Sutus?

There is much to be learnt from a careful examination of the names of places, mountains, rivers, etc., in this region, these generally expressing some marked peculiarity connected with them.

The quarries which supplied the stone for this place are distant, and blocks are still to be seen on a track in the direction of the lake. As there are caverns under the ruins, it has been supposed that some of the building material was extracted therefrom. A friend of mine accompanied Dr. Tschudi in 1858 to the ruins, when the doctor attempted to get down into a cavern, but was glad to be pulled out, as he soon became suffocated.

We feel pretty sure that neither the Aymará or Quichua Indians had tools of iron, but they had of copper, bronze, and even an alloy of copper and silver.

We do not know how they quarried such large masses of stone. Could they have resorted to a method known in the East Indies, that of cutting a groove along a rock, heating the groove with fire, sweeping the fire off, and then throwing cold water on the heated surface, which would split the rock? or could wooden wedges have been used; these kept wet with water, and by their expansion split the rock?

Independently of the devastating hand of time and that of the Spaniard, as this region was, and is still, a great centre of volcanic and earthquake action, these may also have assisted in ruining and dismembering the once great, and to us enigmatic city called Tia Huanaco.

It can scarcely be doubted but that Manco Capac was of Aymará origin. Wars may have disorganized an old Aymará empire, under which Tia Huanaco was built. Manco Capac may have had to fly for his safety from the shores of Lake Titicaca, wending his way north with his Aymará civilization, to which he or his advisers added the idea that he was a child of the sun; and he may have brought together the tribes about Cuzco, including the Quichuas.

Garcilasso says, the tradition of the origin of the Incas from Tia Huanaco was entertained by the people south and west of Cuzco, but that the Indians of the east and north had the

tradition that the Incas first appeared at Paucatambo, or came from there.

The so-called secret language of the Incas was in all probability the Aymará, or one of its dialects; still there seems to have been a more ancient language spoken in earlier times in this country. This appears from the circumstance that there are many words preserved in the Aymará region, as in the names of the principal icy peaks of the Andes of Bolivia, which I am informed are not Aymará or Quichua, as the mountains of Illimani, Illampu, Tacori (Tacora), and others ending in *ri*.

This Tia Huanaco, we may say, was the capital of an old Aymará nation. To have formed such a nation the people must have been warlike, and have extended their country through years of conquests. Then, like all other great states, it had its rise and fall, and then broke up. We have said that Manco Capac may have descended from these Aymará kings; he goes north, founds a state at Cuzco, and his successors having become powerful under another form of civilization, including particularly the worship of Inti, or the sun, these new views are the prime movers in all their wars of conquest, one route of which was south into the Aymará country, where they find the most determined and prolonged opposition to their inroads.

The Incas do not appear to have ever entirely subdued the Aymarás; but with the idea that they, the Incas, had come from the region of Lake Titicaca, they built a temple to the sun on an island in the lake, which was to them a Mecca.

We know that the Aymará language was very different to that of the Quichua, so was the religion, the style of architecture and sculpture, and to this time the Aymarás continue to be a very different people from the Quichuas or Inca Indians. At the present day the Aymará stonemasons are much sought after in other portions of Peru.

Mr. Markham observes, in his *Peru and India*, "The forefathers of the present Aymarás established a civilization of which we have no records, save the silent evidence of those cyclopean ruins of Tia Huanaco and others."

AN ENTOMOLOGICAL RAMBLE.

BY W. E. SHUCKARD.

The main object of this article is to show how much may be observed, and collected, and enjoyed entomologically within a very short range, and in close proximity to the metropolis, not even further than Hampstead. It is to be remembered, that I, essentially a Hymenopterist, had my observation attracted mainly by that highly interesting order of insects, which, for the satisfaction of the uninitiated, it may be as well to state comprises the large group that includes the bees, wasps, and ants; consequently the most elaborately organized, and those whose instincts are most admirably developed of all insects, although the systems abnegate their claims, giving undue precedence to the Coleoptera, or beetles. The Hymenoptera have always four membranaceous, pellucid wings (for the circumstance of some being wingless is usually merely a sexual distinction, and one of those eccentric vagaries which meet us at every turn of Nature, that defy any satisfactory theoretical explanation, receding abruptly as they do from the consecutive series of the normal type), a large and smaller one on each side, which cohere longitudinally at their edge in flight by means of a row of small hooks, and are then spread at right angles with the body, and with them they beat the air; in repose these lie lengthwise down the back, and in some, viz., the wasps, the superior wings take, at rest, a longitudinal fold, the real object of which peculiarity is not to be readily detected; for even the solitary species possess it, and therefore it cannot result from any necessity, or convenience to the social genera in the structure of their nests; besides, it does not occur at all among the bees, either social or solitary. All that we can say is, that Nature knows best; for what do we know? We but grope about in the dark, through which, sometimes, at rare intervals, a faint glimmer momentarily lights the obscurity.

Having vindicated to my favourite order of insects the supremacy due to them, and which I claim for them as their right on behalf of structure, vivacity, and intelligence, I can assure the young entomologist that a bright summer's day's collecting at Hampstead will furnish his cabinet with a choice store and number of the species and genera of the order, provided always that he uses due diligence, and has eyes to see; for the degree of the education of the eye of the practical entomologist is the main means to the successful pursuit of his labours. But practice will greatly develope this faculty,

as it does everything else, and in time he will see and find what an unpractised companion would vainly look for.

In starting for Hampstead, my path lay through the intervening fields of Camden Town, where I did not loiter, for my object being the *Aculeate Hymenoptera* I did not search the hedgerows for other families. It is rarely before half-past seven or eight that the aculeates are upon the wing: but in the broken ground beneath these hedgerows, where several species of *Halicti*, large and small, burrow, and where several *Andrenæ* occur, I have constantly captured the common species of *Nomada*, viz., the *Goodeniana*, *Marshamella*, etc., also the small *Sheppardana*, *infuscata*, and *pusio*, vaulting about in front of the entrance of the burrows of *Halictus rubicundus*, *minutus*, *minutissimus*, *Morio*, etc.; whose exit the *Nomadæ* no sooner observed but these interlopers entered to deposit there their own eggs, to the detriment of the rightful progeny, very many of the *Aculeate Hymenoptera* being parasites—which implies that they deposit their eggs in the nests upon the food stored for the development of the issue of the insect whose labours have collected it, and which their issue consume, to the starvation and consequent abortion of the proper heir. It was in these fields that I first discovered the aromatic and agreeable odour exhaled when caught by the *Nomada Goodeniana*, *Marshamella*, etc., which is of a pungent balsamic character. But many Hymenoptera emit peculiar odours; the little wood-boring *Hylæi* send forth a very sharp but agreeable citron smell, some of the *Halicti* a lusciously sweet but sickly smell, some of the Ichneumons offensive smells of garlic, or still more disagreeable scents; but the capacity is not always co-extensive with the size of the insect, for the smallest sometimes emit it more powerfully than larger ones; nor is it a peculiarity limited to this order, for many of the beetles, and bugs, and caterpillars of the Lepidoptera possess the same property. Thus the *Cicindela campestris* exhales a strong smell of the otto of roses, as does also the musk beetle (*Cerambyx moschatus*), and both exude at the same time a milky fluid which adheres to the fingers; the *Necrophori*, or burying beetles, exhibit a strong smell of musk, some of the *Staphylinidæ* an agreeably sweet smell, for instance, *Philonthus*; in others it is most disagreeable and offensive, and amongst the larvæ of the Lepidoptera there are many which give out peculiar odours, for instance, that of the Goat Moth, which feeds within the substance of the ash, is named from the circumstance of its offensive smell, which has all the rankness of the smell of the goat, and may be detected at a distance from the tree wherein it is feeding. I have also found a whole copse of willows emitting the strong and refreshing fragrance of a garden of roses, it being abundantly inhabited

by the *Cerambyx moschatus*. I merely advert incidentally here to these facts, to show that the emission of odours is not limited to the Hymenoptera, and it is presumable that Nature has furnished it as an auxiliary defence to protect them from their natural enemies; and yet it would scarcely seem restricted to this purpose from the circumstance above stated respecting the musk beetle, in which case it may be a sexual seduction; but *retournons à nos moutons*, for it is quite time that I should now have reached Hampstead Heath, where, enjoying a few balmy minutes upon the summit of the first acclivity up which I have toiled, ascending from Pond Street, where a small clump of firs yields a pleasant shade, and whence may be seen Highgate and its pretty church, whose spire stands boldly out in the blue sky, and whence also a very extensive view may be obtained of the well-wooded undulations of Essex.

My path lay towards the Vale of Health, and passing beyond the inclosures of the grounds and gardens of the mansion which lie to the left of this clump of firs, a bare, sandy continuation of the flat level of this first tableland leads to the valley, and upon this sandy level the first exhilarating indication of the entomological profusion of the district is obtained. I am speaking of a day in the beginning of June, with the wind westerly, yet merely indicated by the slow sailing of a few pellucid clouds across the blue vault of the sky; for, mind you, I speak from woful experience, if the wind blow from any point between north and east, you will look in vain for Hymenopterous insects, or meet with only a few stricken wanderers which wonder why they are abroad, and seem to think, by their desultory flight, of cramps and rheumatism like our poor frail selves, and have not that business-like promptitude and urgency upon the wing which propel their movements when the wind is in the more genial quarter. Here, then, our jocund spirits rejoice at the sight of the ground literally swarming, over a space of about fifty yards, with the little intensely black and hairy *Panurgus ursinus*, the first genus of true bees, which are distinguished from the other large division of *Apidæ*, viz., the *Andrenidæ*, by the double folding of the tongue, detected by the Rev. William Kirby; and it may be as well to observe, that it was throughout this large family that the same respected entomologist (whose admirable labours, conjointly with those of his talented friend, Mr. W. Spence, have done so much towards making entomology an esteemed science in this country, and whose work is a monument of patient research, indefatigable industry, and luminous views) first observed the remarkable sexual peculiarities of structure in the *Aculeate Hymenoptera*, of their having in the male sex one joint more in the antennæ, and one segment more in the abdomen, than in the females.

Here, then, *Panurgi* abound in such profusion that you cannot step without treading upon them, as some, issuing forth from their burrows, which are made perpendicularly in the sand, and others returning covered and laden with yellow pollen collected from the neighbouring composite flowers, look like little sweeps gaudily trimmed out on May-day with garlands of daffodils; and here in the vicinity the lazy males are sleeping or basking, curled up amongst the petals of these flowers, whilst hovering over the burrows in watchful impatience, their pretty parasite, the *Nomada Fabriciana*, may be found in almost equal abundance. And I would here just observe upon the assumed scarcity or abundance of insects, that although some insects may not be produced individually so numerously as others—this exclusively depending, as I assume, upon the function they specifically exercise in the economy of Nature—yet I have always found, even of rare species, a very sufficient number when I have happened to hit upon what I may designate as their metropolis, from the analogy of man herding collectively in those centres, and of which I shall have several instances to adduce in the course of this paper. Leaving the height, and descending through the broken and picturesque ground, studded with the golden whin in full blossom, towards the pond at the bottom, which, by the by, abounds with water insects, about half way down, lying a little to the left, I came upon my elegant species of *Andrena*, the *A. longipes*, which I often had a notion was semi-social, for I have seen several individuals constantly frequenting the same burrows, which are made obliquely in the sand, and in almost contiguous proximity. They occur in as great profusion as the *Panurgus*, so that many hundreds might be caught in a very brief space of time, though exclusively females, for I have rarely discovered the males of the *Aculeate Hymenoptera* numerous at their respective metropoles, but have usually found them scattered amongst the neighbouring flowers, or jaunting about upon the sunny side of the leaves of shrubs or hedgerows in the vicinity. Just below this spot, and before coming to the pond, I have found both males and females of the bee *Anthophora retusa*. In these, dissimilarity of sex is remarkably conspicuous. The female is of a deep brown black, with golden polleniphorus posterior tibiæ; whilst the male is of a rich olive brown with a yellow nose, and whose intermediate tarsi are singularly long and slender, and fringed with a thin feathery edging. These insects were in such abundance that I could have filled hats with them, and of the male I was very insatiate, it being such an elegant creature. *Andrenæ* also occur in this spot, as well as the beautiful *Melecta punctata*, with its black burnished body, and series of milky white spots on each side of the abdo-

men, decreasing in size to the apex, like the buttons of a lady's dress.

I have often been much amused at observing with what vehemence and pertinacity this cuckoo bee is assaulted by the female *Anthophora*, which endeavours courageously to prevent its entrance to her burrows, and in the combat they have fallen rolling upon the ground, whence they have risen after a shake, and flown off, urged by the impulse of their instincts; and although the *Anthophora* is much the largest insect, the *Melecta* is the more agile opponent, and, like a belted knight, looks formidable in its bright armour. No satisfactory theory seems to meet the difficulty of the parasitical *Aculeate Hymenoptera;* and although Pelletier de St. Fargeau endeavoured to frame one upon the presence or absence of spines externally upon the posterior tibiæ, and upon which he based his classification, it does not hold good, being contrary to experience in many cases, and he could not apply it to the bees. Here we find *Apidæ* parasitical upon *Andrenidæ;* to instance no more than one, that pretty insect the *Epeolus variegatus*, is parasitical upon the *Colletes fodiens*, and where this burrows it is in abundance, and is as numerously accompanied by the *Epeolus* as is the *Panurgus* by the *Nomada*. Here we have also the true bee upon the pseudo-bee; and as in the case above-mentioned of the *Anthophora*, we have the true bee upon the true bee, as also in the case of *Nomada Schæfferella*, which is parasitical upon *Eucera longicornis;* and in *Sphecodes* we have the pseudo-bee upon the pseudo-bee, as that rears its young at the expense of *Halictus*. I think, but I am not certain, that each parasite has its specific insect to prey upon, although in several instances I know that some have more than one parasite, nor are they all restricted to the same family, for the *Chrysididæ*—those sparkling gems—are frequently parasitical upon the bees, although more frequently upon other *Aculeates; Mutilla* is parasitical upon *Bombus*, and this in *Psythyrus*, a very similar hairy bee to itself, has its own peculiar cuckoo.

But from this interloping digression I will return, and now find myself edging the pond in the hollow, bearing to the right; and in the broken ground between the fields and the houses in the Vale of Health, which is threaded by a pathway leading across the heath, and skirting the inclosures of Lord Mansfield's park, there is one shallow pit where my choicest captures have been made; for there I have taken as many as eight specimens in a very short space of time, of the hitherto rare *Methoca Ichneumonides*, the male of which (formerly called *Tengyra Sanvitali*, before they were identified as the same species), is still more rare, and which I have caught there but twice. Its flight is very peculiar, being excessively rapid, and it requires great

promptitude to secure it, and when it alights it runs along with immense velocity, very much like some of the *Staphylinidæ*, twisting its abdomen about with agility; the female is apterous, it being one of the solitary *Heterogyna*. I consider this insect to be the European analogue of one large section of the *Thynni* of New Holland, for it has similarly-constricted segments of the abdomen, and curved joints to its long and slender antennæ; and the males, like many of those males, a curved hook at the extremity of the abdomen, and I presume its habits are the same, but with which I am not acquainted. Like them, too, in most cases, the males are black, whilst the females are fulvous, bright brown, or red; but Nature is very eccentric frequently in the great disparity of the sexes, whilst in other instances it is remarkably uniform, the reason of which we shall never unravel; but viewing it in a Darwinian light, is it a convulsive divergence towards the formation of a new species, which has rested abortive when half accomplished? This fails to be confirmed by never finding the normal or uniform type whence the start has been made. In fact, our collections are enlarged enormously in the number of species, and even genera, by these sexual differences, which prevent our collocating the dissimilar forms and the divergences of colour until direct experience gives us its assistance, and we are repeatedly in doubt as to the correlative affinity of a vast number of insects, a doubt we shall probably never solve; thus, even the female of the common European *Myzine* is not yet known, and which must certainly be apterous. In this same sand-pit I captured *Myrmosa melanocephala*, but never its black male, and also *Mutilla calva*. Upon the fences, gates, and hedges which have a sunny aspect, and which separate the heath from the adjoining private property on the left, a great many of the *Crabroes* swarm, particularly the *cribrarius* and the *patellatus*, also the genera *Pemphredon*, *Trypoxylon*, *Diodontus*, *Ceratophorus*, *Passalœcus*, in most of their species, a good many of the *Pompili*, and very many of the wood-boring bees.

The ground now gradually ascends, and on the elevated plateau which intervenes between the Vale of Health and the road leading to Highgate, *Mimesa bicolor* and *equestris*, and *Cerceris arenaria*, which in flight looks extremely large, and also an abundance of the *Ammophila sabulosa* occur. They are all engaged in conveying their prey to their burrows, as pabulum for their young, that of the *Cerceris* being *a curculio*. And here it is most interesting to watch the assiduity with which the *Ammophila* and the *Pompilus viaticus* drag along their prey of spiders over every obstruction. When interrupted they drop the prey, and take a reconnoitering survey. If they extend this too far and thus lose it, they have to hunt up and down to recover it, which they do with great pertinacity. To try them I

have sometimes removed the spider, and it is then curious to watch their painful and useless labour, which they will not intermit until they have carefully gone over every inch of the ground, and then even very reluctantly.

A fine harvest may be made upon this flat, but nothing very rare is found, excepting perhaps the *Psen equestris;* several *Oxybeli* occur in profusion, also many of the dipterous parasites of the Aculeates; and there is one, a little silver-faced fellow, who has not the least fear of the stings of his exasperated foes. Passing now across the high road to Highgate, the Heath descends very abruptly, is very much broken, and is studded with many clumps of furze all in full bloom, interspersed with occasional levels which have their little pools of water alive with water insects. This side, from its aspect, which is northerly, does not abound with the Hymenoptera, but retrieves in quality the dearth of quantity; for upon a small acclivity—bending to the south, and dotted with sparse and stunted furze, and having on its brow on the edge of a sand-hill a dwarf oak, whose gnarled roots thrust their knees in all kinds of grotesque shapes through the slightly superincumbent soil, which has been gradually abraded by the weather—I have taken amidst the furze, not on it, the beautiful and conspicuous *Hedychrum roseum* and the *Arpactus tumidus,* as also the *Nysson trimaculatus,* all in numbers. To the left, in a wide open space of this portion of the heath, I found the metropolis of what was once the rare *Astata boops,* but which my captures made common. In this species the female is less frequently found than the male; both are handsome insects, the female much resembling in form the *Larra anathema,* whilst the male, in the smallness of its conical abdomen, the enormous size of its eyes, which occupy nearly the whole of the head—in this much resembling the male of the honey-bee—is very peculiar. He is further remarkable amongst the *Aculeate Hymenoptera,* as selecting the centre of a clear space a few yards in diameter to settle upon some small clod there, whence he makes a wide circuit in the air, returning repeatedly to the same spot. These are the few Hymenoptera I have caught on this side of the heath, but nowhere throughout the heath have I taken any species of *Gorytes,* but one *Nysson,* one *Tachytes,* and neither *Mellinus* nor *Philanthus.* Abundance of *Bombi* occur, as also several *Psithyri,* and of course the nests of the former, as well as the habitation of several of the ants, upon the skirts towards the cultivated ground. The other side contains the gold-fields for collectors; but I would remark even with respect to this profusion of insect life, that it appears to be intermittent, not uniformly the same every season, and seems to follow laws irrespective of barometrical or thermometrical influences, it is between the

hours of ten and four that they chiefly abound. I have not alluded to the very many genera and species of the other orders that may be found here under propitious circumstances. I was exceedingly fortunate in the peculiarity of the day, which was in a season when May was really May—sunny, and balmy, and beautiful, the hawthorn at the very commencement of the month exhaling the rich odour of its clusters of flowers. By this time it was past six, and I was fairly tired, and my spirits exhausted from continued excitement; I repaired to "Jack Straw's Castle" to have a chop and glass of stout, and whilst this was preparing, I took a furtive glance at my choicest captures, being careful to shut the windows for fear of any escaping; but it is interesting to let one or two at a time loose, for they fly to the panes of glass, and thus their different modes of progression may be watched quietly, and they themselves can be recaptured at pleasure. Speedily finishing my simple repast, I gathered up my gear and walked leisurely back over the heath, retracing mentally all the varied sensations of the day, and enjoying, as I was recrossing the meadows homewards, the beautiful sunset with the rapidly-varying opaline tints of the sky, the progressive mutation of sunlight into twilight, and that into the gray semi-luminous beauty of a summer's eve verging into night, with the lustrous moon shining above, and inspiring the incense of the fresh-mown hay, which made the air balmy with its fragrance.

MARINE AQUARIUM.

WITH TIDAL ARRANGEMENTS.

The so-called "mania" for aquaria may have passed away, though the taste remains in intelligent circles, and those who desire to acquire a knowledge of marine animals still persevere in attempts to domesticate them, and occasionally with more success than is generally supposed or known.

A description of one of the most successful tanks, and its system of management, may not be uninteresting to such as have only failures in the like pursuit to regret, and, from the delight expressed by many who have seen the aquarium about to be described, perhaps to readers generally.

The public exhibitions in London of aquaria, constructed when the taste was first developed, are not altogether satisfactory. It seems, therefore, proper to consider if something better cannot be done, and to ascertain if practical experience, observation, and common sense have not now added their maxims to those principles which theory in the first in-

stance suggested. Some few attempts in such a direction have been made in this country, almost in all instances by amateurs. One aquarium also, on nearly the same principles as will be described below, only worked by different apparatus, was put up at the late Exhibition at Kensington, but, owing to an accident, it was not completed till too late for its effectiveness to be shown; the Exhibition in fact was half over before it could be got into condition, and its presence, in the earlier months, full only of dirty water, was prejudicial rather than otherwise to an interesting pursuit. The Society for Acclimatization of Animals in France have now an aquarium of the same method of construction and arrangement, or nearly the same, at their gardens in the Bois de Boulogne, and which has more compartments to provide for the separation of animals; but similar attempts in this country to obtain a successful result with unchanged sea water, are in the hands of amateurs, and that which forms the subject of this paper was one of the earliest, preceding even the one at Paris.

The aquarium now to be described is 9 feet long in front, 4 feet 3 inches wide from front to back, and 27 inches deep, and contains when full 400 gallons of sea water, divided into three compartments of equal size, each therefore holding about 133 gallons. This large tank is constructed of strong slabs of slate, viz., one for the bottom, and one for each of the sides, and back, and for the divisions into compartments, while the front only is of glass, of three stout squares of plate, firmly cemented into grooves cut in the slate slabs and into a bar of slate that goes over the top. The facings of the slate work are moulded, and their surfaces planed and rubbed smooth, so that it can be decorated by paint and gilding, and thus rendered ornamental if desired. Inside the divisions, slabs of slate are reared from the bottom, at one-third the distance from the front, sloping upwards to the back, and reaching to within about six inches of the surface of the water when the tank is full. The rockwork is built on this sloping shelf, and up the sides of the compartments. In front of the shelves the bottom of the tank is covered by two or three inches of fine sand, with a rock here and there, and shells, and so forth. There is thus presented to the view of a person looking in through the glass front, an imitation on a small scale, of a shelving rocky shore, very convenient for a view of all the creatures affixed to or roaming about thereon. We might indeed suppose one of the little tide-pools of the sea-shore to have been cut in two, and the half of it to have been raised to the level of the beholder's eye. The angular space behind the sloping bank is a dark water chamber, the water passing in and out, when any motion is given to the fluid in the aquarium.

Those readers who are acquainted with what has been done in aquaria during the last four or five years, will recognize in the above description "a patent slope-back tank with dark water chamber" on a large scale; but it was necessary to describe the arrangement, as all may not have seen that form of tank, which has its special advantages over every other yet devised, as will be explained later on. To such as have seen these tanks only on a small scale, the comparison with the half of a tide-pool of the sea-shore will perhaps be deemed imaginative; but let them consider the advantage which the size of the tank described gives for the arrangement of the rockwork, how much better an effect can be produced by the use of bolder masses, by making rugged sides, by forming miniature caves, by the tumbled-down appearance that can be introduced here and there, and by little indented bays with small sand ridges which the tide has washed—all of which can be accomplished with sufficient space, as in the one described, but is not quite practicable in a wash-hand basin aquarium. Added to these advantages, if a good and varied coloured vegetation can be induced to grow, and living creatures preserved in health, an artificial section of a tide-pool will perhaps approach the reality of a natural scene.

Before proceeding further, it is well to make some slight allusion to previous attempts by the same owner with aquaria of smaller size. Three will be sufficient to refer to, viz., a small vase for one; another, a double cube, 3 feet, 18 inches by 18 inches, all glass sides, and thirdly, a patent slope-back dark water-chamber tank, of about 33 inches square, 16 inches deep, holding 60 gallons, or thereabouts. The cube was found a very objectionable form; in vases, according to slope and depth, some limited amount of success may be obtained—when the depth is only about a third or fourth of the diameter it is best; but it was the results obtained with the third form that led to the construction of the larger tank. That third vessel was placed close to a large window facing the north, in which situation, by a little attention to shading in summer when the light is strong, the water is kept clear with the greatest ease, provided that decaying animal substances are not allowed to accumulate. If a small number of animals, say only ten individuals, of appreciable size, were kept in such a sixty-gallon tank, it is probable that, with a little feeding now and then, they might survive with tolerable comfort; but it was found that such a stock as most people would wish to see in an aquarium of such dimensions could not be satisfactorily maintained. It should be considered satisfactory when the creatures live to the full term of their natural life in proper size and beauty, but not so when they gradually

dwindle away, as anemones in confinement usually do. They dwindled in the said aquarium, notwithstanding every effort was made to feed them sufficiently. They gradually lost the power of taking food when offered, and the conclusion was inevitable, that an aquarium with stagnant water, however well aeration might be performed by oxygen derived from growing vegetation, and by absorption from atmosphere at the surface, did not supply such conditions as suited sea anemones, and that those only could be satisfied with such an aquarium who did not mind seeing their creatures dwindle away, renewing them with fresh specimens from the sea, to die away in like manner in turn.

Some experiments were then made in the same tank with a view of seeing if a better arrangement could not be adopted. The old practice of syringing the water, beneficial to some extent, is not convenient, yet motion of some kind seemed wanting, as the sea is always in motion. Moreover, when syringing was tried, it did not seem to be thoroughly to the taste of the creatures. A better kind of motion was that caused by a pair of flexible wooden nippers, the blades of which should be about an inch asunder, held in the hand perpendicularly in the water, in one corner of the tank, dipping from one-third to one-half the water's depth. A motion being given to these by action from the wrist only, they are made to perform a cone-like revolution in the water, and by a little additional impulse applied when at one part of the turn, and three strong strokes, followed by three lighter, and then a pause, three waves are driven round the tank, on the top of a good current, much felt in the shallower water, but also more gently in the deeper. The current will gradually cease as the motion of the nippers or spindles becomes slower, and stops, but will be followed by a rippling, which will last a little while. Before it has subsided, the action of the hand should be resumed, in an opposite direction, so as to reverse the course of the current, and so on alternately. So good an effect will not be produced by a single stick as by the double spindle, because, with the latter, more air is carried down, and dispersed in minute bubbles throughout the tank, and it seems to make the current and wave better. By such motion a very efficient aeration is caused, all the water being continually brought to the surface, and in contact with the atmosphere. It was subsequent experiment that proved the full value of this kind of motion, but at the time of first trying it, the necessity of agitation of some kind or other was made apparent, for anemones which had been long confined, and were rarely expanded before, gradually opened under its influence, and after two or three days' perseverance in it, for half-an-hour or so twice each day, those

anemones which, even when casually expanded, would not take food before, retained and swallowed eagerly any morsel that was dropped into the current so as to come within reach of their tentacles. Such anemones also began in a very few days to show signs of improved condition. The effect then was seen to be beneficial, but the operation was liable to one of the same objections as the use of the syringe, namely, that it had to be performed by hand, thus requiring time and regularity, and therefore not always convenient to be done. Various projects were considered for getting over this difficulty, and it appeared that if something like the fan of a screw steamer could be got to work for a few hours each day, or better, continuously, by some simple kind of inexpensive and not bulky machinery, it would do; but the representations of others, that it was impracticable, deterred any further attempts in that line for the time,—and possibly for small aquaria it could not be accomplished at a sufficiently cheap cost to make it worth while, but for large tanks, such as public museums or zoological gardens should have, there is nothing impracticable in it.

Besides this question of moving water, others forced themselves into notice. Principally, that tanks must be very much enlarged, or the number and variety of creatures kept in one single aquarium much reduced. Anemones, if expected to show beautifully, ought not to be crawled over every ten minutes by a crab, nor a prawn compelled to make half-a-dozen attempts before he could settle down clear of an anemone, and so escape its nettling threads. It was pitiful to see the tails of mullet half nibbled away by sticklebacks, and evident that in a tank stocked with all these, the multiplication of those small creatures, the entomostraca and infusoria, on which some of the sedentary animals chiefly subsist, was a complete impossibility, for the active swimmers almost exterminated them. Thus there was positively no natural food for any kind of creature excepting those which live upon vegetation and vegetable spores, but all else became entirely dependent upon being fed by hand. Not only, therefore, the enlargement of tanks, but also the separation of creatures whose habits were very distinct from one another, seemed a point to be desired; and, if added to this, some control over excess of temperature could be had, one could not understand why creatures within reasonable limits as to number and size should not be successfully kept. Perpendicular light, instead of the side-light of a window, was also thought about, as the most natural, and therefore likely to be generally the best, both for animal and vegetable life. When shade was wanted, it could be arranged for by projecting pieces of rock, and other devices.

It was in the years 1858 and 1859 that the experiments

and observations recorded above were made, and in the latter year the large tank with three compartments, as first described, was determined upon. It was made tidal as follows, if the expression, "tidal," is not too grand :—

A cistern was constructed underground, of brick, lined with Portland cement, and, before covered in, tested, and ascertained to be perfectly watertight. In it, at one corner, is fixed a filterer—a slate vessel, filled with sand and shingle, alternate layers, and larger pebbles at top. This filtering medium, of sand and shingle, does not rest on the bottom of the slate vessel, but on a slab of the same material, perforated all over with small holes, drilled regularly through. This slab is fixed in the filterer so as to leave a space of about two inches from the bottom, to allow of water to pass into it freely from the aquarium, and to rise through the perforated slab and filtering mass, then to trickle over the top of the filterer into the cistern. The latter was then made secure, and covered over at such a depth under the soil that neither heat nor frost could exercise much influence on its contents.

Close beside this cistern, but not over it, the building was erected for the aquarium itself. It was placed against the north end of a dwelling-house, and formed like an attached greenhouse, but with walls of brick; the roof being of glass, and one window looking northwards, towards which quarter also the roof shelved; there was no other illumination but from the window and roof. The aquarium was put up on firm supports in this building with its glass fronts inwards, that is, towards the house, sufficient space for spectators to sit at and to pass all round the tank being provided. The inside of the wall is coloured a neutral tint, and a portion of the glass roof painted black, namely, that part over the space between the fronts of the tank and the house-wall, and a little more. Slate covers also were provided for the top of the deeper part of the tank, extending over about one-third of its width, and giving a partial shade beyond. The effect of this arrangement is, that the spectator himself is out of direct illumination, as also is the front part of the tank, while the light falls strongly on the surface of the shallower water at the back, and zones of various shades of light extend from thence to the deeper water. The light falling on the glass fronts is so very modified in power that vegetation scarcely grows upon them. A slight sponging every month or two, according to season, keeps them perfectly clean, so that a bright view through them into the interior of the aquarium is a matter of no difficulty. The zones of light are adapted to the requirements of a varied vegetation, whilst both plants and animals are brought out better, as they stand in relief against the back light, as we see any object on a hill against the sky.

A third cistern is placed outside, at a considerably higher level, in the open air, in an angle formed by the walls of the house, in a situation sheltered from the sun.

In each compartment of the aquarium there are siphons with stop-cocks below, all leading into a main pipe that takes the water into the lower cistern through the filterer. From thence it is pumped up to the upper cistern last mentioned, and allowed to flow back into the aquarium through fine jets; or water can be forced from the lower cistern direct into the aquarium itself. There are stop-cocks to check the flow in or out of any compartment; but it is not intended to describe this apparatus particularly, afterthought having suggested other efficient and much less expensive plans of producing the same effect. All at present needful is to show that the water can be let out of the aquarium either wholly or in part to any depth required, and forced back again from the upper cistern or from below direct. If from above, the force of the jet will depend upon its size, and the height at which the upper cistern is situated, and thus the amount of stream or aeration in the aquarium, and the time it occupied in refilling it, can be adjusted at will. Let us suppose that the water has been permitted to run out of the aquarium, and leave the upper stones and anemones on them dry, as on the sea-shore when the tide is out.

The length of time of their exposure to the air is regulated by the strength of the jets and the turning of the stop-cocks, and it may be done once or twice daily, or only when thought needful. Before returning, the water has been filtered and cooled in the lower cistern, and the jet impinging upon the surface of the remaining water in the tank, at a certain angle, drives down with it an immense quantity of air, which becomes dispersed throughout the tank in minute bubbles. A very fine jet is sufficient to create a stream of water and air in every part of the tank, and the stream can be kept continuously running in one or all the compartments if desired, there being overflow pipes to carry the surplus water back again below, when the aquarium itself is full after giving tide. For this purpose a little more water was supplied than necessary to fill the aquarium, and which surplus water remains ready for use in the lower or upper cistern when the jets are not running. The above can be made so self-acting in any suitable situation as to require only very little personal attendance daily.

To sum up the whole, the means are provided in this aquarium for exposing the creatures and vegetation to the action of the atmosphere, as on the sea-shore, during which exposure any noxious gases escape freely, and a purification of the tank is effected. There is also a continuous movement, a change and aeration of the *same water*, which may be used over and

over again; a control over excessive ranges of temperature; provision for perpendicular light, and for a beneficial regulation of the amount of it.*

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. CHAMBERS.

(*Continued from page* 101.)

107. On September 13, a strange star appeared to the S.W. of δ and ϵ Canis Majoris.—(Hind.)

108. On July 25, a comet appeared in Ursa Major, with a tail 2° long, which extended in a S.W. direction toward κ and ι of that constellation.—(Hind.)

110. In January, a comet rose to the S.W. of γ and ζ Eridani. It had a bluish tail 6° or 7° long, pointing to the N.E., in which direction it moved.—(Ma-tuoan-lin.)

115. On November 16, an extraordinary star appeared in the west. On November 21 it was to the S. of β and α Aquarii, and afterwards moved to Musca and the Pleiades.—(Gaubil refers this comet to 117.)

123. In December, a strange star was seen in the region near α Herculis and α Ophiuchi.—(Hind.)

132. On January 29, a strange star, with a tail 2° long, pointing towards the S.W. was observed. Its R. A. was 6° greater than that of β Capricorni; it was also seen near δ Sagittarii, and moved near β Aquarii, α Equulei, and α Aquarii, towards ϵ and θ Pegasi.—(Ma-tuoan-lin.) This comet was seen in Europe in the time of Adrian, whose courtiers told him that the soul of Antinoüs had been changed into a new star.—(Dion Cass. lxix.)

133. On February 8 an extraordinary star, with a vapour 50° long and 2° broad was seen to the S.W. of γ Eridani.—(Hind.)

149. On October 19, a comet, with a tail 5° long, was observed in head of Hercules; it was only seen for four days.—(De Mailla, iii. 441.) Gaubil says that it appeared in 148, and Ma-tuoan-lin, in 147.

* It should be known that the magnificent aquarium described by a contributor in the preceding pages is the property of Frederick Drabble, Esq., of Llandudno, N. Wales, and having had frequent opportunities of visiting it in September, 1862, we can bear testimony to the unusually fine condition of its living inhabitants, and to the kindness and courtesy of their owner, whose devotion to marine zoology has been rewarded by signal success.—Ed. I. O.

161 (i.) In February or March a comet was seen near α Scorpii.—(De Mailla, iii. 459.)

161 (ii.) On June 14, an extraordinary star appeared in the R. A. of α Pegasi. It remained stationary for some time, and then retrograded, and when it had reached the R. A. of 14h. it threw out a tail 5° long.—(Ma-tuoan-lin.)

180 (i.) In August or September a comet was discovered near ν and ξ Ursæ Majoris. It moved eastward to the tail of Leo, and disappeared in three weeks.—(Ma-tuoan-lin.)

180 (ii.) Another comet was visible in 180 for two or three months in the winter. It came from the E. of Sirius, and moved to υ Hydra, where it vanished.—(De Mailla, iii. 506; Ma-tuoan-lin.)

182 (i.) In February, March, or April, a comet was seen near δ Andromeda. It tended towards the E., entered the circle of perpetual apparition, but left it again after three days. It was visible for nearly nine weeks.—(Ma-tuoan-lin.)

182 (ii.) In August or September, a comet appeared near ι and κ Ursæ Majoris, which was also seen in the vicinity of β Leonis.—(De Mailla, iii. 507; Ma-tuoan-lin.)

188. A comet was observed in March or April.—(De Mailla, iii. 520.)

190±. During the reign of Commodus, a hairy star was seen.—(Ælius Lampridius; Herodian, *Hist.* i.) No more exact date is assignable.

192. In September or October, or perhaps a little later, a grand comet 100° long was seen to the S. of α Virginis.—(Ma-tuoan-lin.)

193. In November, a comet was seen near α and ζ Virginis, moving towards the N.E.; it arrived in the region near α Hercules and α Ophiuchi it disappeared.—(Ma-tuoan-lin; De Mailla, iii. 563.)

200. On November 6, a comet was observed near δ Serpentis.—(De Mailla, iv. 35; Ma-tuoan-lin.)

204. In November or December, a comet appeared in Gemini, which passed by δ Cancri to near β Leonis.—(De Mailla, iv. 40; Ma-tuoan-lin; Dion Cass. lxxv. 16.)

206. In February a comet was observed in the square of Ursa Major; the tail extended over the whole of the circle of perpetual apparition; it reached to Ursa Minor.—(De Mailla, iv. 43; Ma-tuoan-lin.)

207. On November 10 a comet appeared in Leo.—(Ma-tuoan-lin; Couplet.) De Mailla assigns this comet to the previous year.—(*Hist. Gén.* iv. 45.)

213. In January a comet appeared near θ and υ Geminorum.—(De Mailla, iv. 63.)

222. On November 10 a new star was observed between

β Virginis and σ Leonis.—(Gaubil.) It is uncertain whether this was a comet or a temporary star.

225. On December 9 a comet was discovered near *m* Leonis; it traversed the head of Leo.—(Ma-tuoan-lin.)

232. On December 4 a comet was seen near σ Leonis. It approached β Leonis.—(Ma-tuoan-lin.)

236 (i.) On November 30 a comet, with a tail 3° long, was seen near α Scorpii; on December 1, it (or another comet) was seen in the E.—(Ma-tuoan-lin; Gaubil.)

236 (ii.) On December 15 a comet was seen between θ and ζ Herculis.—(Ma-tuoan-lin; Gaubil).

238 (i.) In September a comet with a tail 3° long was observed in Hydra and Crater: it moved eastwards and disappeared in six weeks.—(Gaubil; Ma-tuoan-lin.)

238 (ii.) An extraordinary star was visible from November 29 to December 15. It moved from α Aquarii through the north of Pegasus, by Cygnus, and the W. of Aquila, to near γ Ophiuchi. —(Ma-tuoan-lin.)

245. On September 18 a comet with a tail 2° long appeared near α Hydræ: it moved towards Crater, and remained visible for three weeks.—(Gaubil; Ma-tuoan-lin.)

247. On January 16 a comet with a tail 1° long was observed; it had the same R. A. as Corvus, and was visible for eight weeks.—(Ma-tuoan-lin.)

248 (i.) In April a comet was seen in the Pleiades. Its tail was 6° long and extended towards the S.W.—(Ma-tuoan-lin.)

248 (ii.) In August a comet appeared having the same R. A. as Crater; but which gradually increased. The tail was 2° long, and it remained visible for six weeks.—(Ma-tuoan-lin.) Pingré (from Gaubil) says it was in the *constellation* Crater, and not in the *sidereal division* of Crater, as Hind gives it.

251. On December 21 a comet appeared between α and β Pegasi. It moved westwards, and disappeared after thirteen weeks.—(Ma-tuoan-lin.)

252. On March 25 a comet was observed in Musca, with a tail 50° or 60°, stretching towards the S. It afterwards passed between the bright stars of Orion, and was seen for three weeks. —(Gaubil; Ma-tuoan-lin.)

253. In December a comet appeared near γ Virginis. The tail pointed to the S.W., and was 50° long. It remained visible six months.—(Ma-tuoan-lin.) Hind remarks that probably the comet's motion was retrograde, and therefore it receded from the sun's place towards the W.

254. In December a vapour emerged from near δ Sagittarii. Its length is stated to have been very great.—(Ma-tuoan-lin.) Pingré doubts whether this was a comet or not.

255. In January or February a comet was observed in the N.W. near the horizon.—(Ma-tuoan-lin.)

257. In November or December a white comet was seen near α Virginis.—(Ma-tuoan-lin.)

259. In November or December an extraordinary star was seen near β Leonis. It moved towards the S.W. and disappeared in a week.

262. On December 2 a comet with a tail 50° long appeared near κ Virginis. It moved towards the N. and was visible for six weeks.—(Gaubil.) Ma-tuoan-lin says it had only a tail five tsun long, whatever that may mean.

265. In June a comet was seen near α and β Cassiopeiæ. Its tail was 10° long and pointed to the S.E., and after twelve days it disappeared.—(Ma-tuoan-lin.)

268. On February 18 a comet was seen in Corvus. It advanced to the N.W., and subsequently turned towards the E. (Ma-tuoan-lin), which remark probably has reference only to the tail (Hind).

269. In October or November a comet was seen within the circle of perpetual apparition.—(De Mailla, iv. 148.)

275. In January or February a comet was discovered in Corvus.—(Ma-tuoan-lin.)

276. A comet was visible from June 23 to September. It moved from near α Libræ, by α Boötis to β Leonis, and attained to χ Hydræ, the square of Ursa Major and Ursa Minor.—(Ma-tuoan-lin.) Hind suggests that in place of reading the group of χ Hydræ we should read the sidereal division of χ Hydræ, in which case the several positions may fairly be considered as applying to the motion of the head and the direction of the tail of one comet, though Ma-tuoan-lin states there were three.

277 (i.) Ma-tuoan-lin says that in January or February there was a comet in the W., and in April or May, another in Musca, which two are probably identical.—(Hind.)

277 (ii.) Ma-tuoan-lin says that there was a comet in May or June, near π Leonis, and another in June or July in the W., whilst De Mailla (i. 162) speaks of a third within the circle of perpetual apparition in August or September. Hind thinks that these three are one.

278. In May a very large comet appeared in Gemini. It lasted eight months (?)—(Ma-tuoan-lin ; Gaubil.)

PLÜCKER'S RESEARCHES IN ELECTRICITY.

BY ALEXANDER S. HERSCHEL, B.A.

The able investigations of Professor Plücker, of Bonn, on the discharge of electricity of tension through rarefied gases, continue to add new revelations and fresh confirmations to our acquaintance with the operations of this subtle and powerful agent. It is now a quarter of a century since Professor Faraday, in his original researches, developed the theory of the molecular character of every transfer of electrical activity from place to place. From the induced excitations of Franklin's doubly-coated plates of glass, to the evolution of chemical elements at the immersed poles of a galvanic circuit in a fluid, all permanent and fugitive electrical affections were rightly ascribed by him to carrying powers residing in the ultimate molecules of interposing substance. The same theory receives new illustrations in the experiments detailed by Dr. Plücker. The well-known Ruhmkorff coil is the powerful electro-motive source of the new effects. On the principle of the Neaf's hammer and Bull's battery of our medical electricians, a primary current in this instrument, enveloping a core of iron, produces, by automaton interruptions and restitutions of its own passage, rapid and powerful pulsations of electricity in a secondary coil of wire collateral with the former throughout their common length. To comprehend the origin of these pulsations, we return to the mutual influences, one upon another, of a galvanic current and a magnet, first discovered by Oersted, extended by his successors, Ampére, Arago, and others, and ably investigated by Faraday.

It is a well-known fact that the northerly point of a mariner's needle will be driven from the front towards the right of a descending current of electricity; or if fixed, will cause the current and the conductor, if free, to shift to their left; so that, if permitted, the latter would circulate continuously with the hands of a watch about the summit of the needle. Professor Faraday, however, showed that the mere motion alone, of the kind indicated, either on the part of the needle or of the conductor, is sufficient to cause in the latter an *as*cending current of electricity. Such a reverse current opposing the primary current, where motion of the needle or of the conductor is permitted, occasions in it a loss of power proportional to the effect produced. Transportable currents may thus become enfeebled in the presence of a powerful magnet in proportion to their mobility; and it is highly probable that the vacillatory appearances observed in Mr. Plücker's vacuum discharges, when, by suddenly exciting a powerful electro-magnet,

the current is thrown from one side to the other of the tube, may offer in this view, as will afterwards appear more fully, a complete illustration of the fitful and mobile beams of the Aurora. Sudden motions of the magnetic poles in the collateral wire, and especially in the iron core or centre of the coil, on the first passage of a galvanic current through the primary wire, may be employed to account for the reverse current which then for the instant appears in the collateral or secondary wire; while the sudden return of the poles to their original arrangement on cessation of the primary current would generate a similar impulsive current through the same coil, in the opposite or primary direction. Of the condition assumed by the secondary wire *during* the passage of the primary current, known after Dr. Faraday as the "electrotonic" state, no appliances have hitherto detected evidences beyond the two different currents that attend the moments of its assumption and dismissal. Unlike the currents which circulate in a coil on moving it near a magnet, or on heating the place of contact of two dissimilar metals, these characteristic currents are impulsive and momentary. It was discovered by Mr. Ruhmkorff that connection of the two wires of the main or primary coil, near the battery, with the inner and outer coatings of a Leyden jar, or with the two opposed plates of an extensive condenser, greatly exalted the effects. Free electricity accumulates abundantly upon the plates from the voltaic pile before the contact is renewed, thus enabling a stout wire of few convolutions to produce suddenly a high degree of magnetization, while in Mr. Ruhmkorff's construction an extensive coil of fine wire is made to absorb nearly the whole of the reaction of the iron. From the freedom with which electricity traverses metallic conductors, a great accumulation and high tension is occasioned at the extremities of the induction coil. Vivid sparks approaching to an inch in length may be drawn between them; but it is evident that if not so relieved, the tension on cessation of the impulse will neutralize itself by return within the wire, and be succeeded by tension of the opposite character on the following pulsation of the coil. Glass plates of one-eighth of an inch thick and upwards may be perforated by the tension, heightened by proximity, of the terminal wires.

If single metallic coatings upon two plates of glass be connected with the termini in such a manner that the plates of glass may oppose each other at a distance of an inch or more, sparks pass between their faces on arrival of the current. The same occurs in all the intervals of air, when the terminal wires are withdrawn a short distance from the outer metal sheets. The complete explanation of these sparks, first noticed by M.

Dumoncel, is due to the labours of Mr. Gassiot and Dr. Plücker, and with the new ingenious modifications of Geissler's vacuum tubes they become the most beautiful illustrations of Professor Faraday's theory of induction.

If the terminals of a Ruhmkorff coil be inserted in two separate exhausted tubes of air or other gas, and the coil be excited, brush discharges emerging from the wires extend almost to the boundaries of the vacuum cells. These are wonderfully intensified by partly covering the exteriors of the cells with tinfoil, and effecting metallic communication between the coats. But, again, the same effect will be produced if, in place of a distant metallic communication, the cells are closely applied to one another, by dividing a single tube into two cells with an inserted diaphragm of glass. A third cell may be interposed between them, by employing two diaphragms of glass; and will then appear to act like the metal, causing no diminution of brilliance in the terminal spaces, but itself glowing with a similar discharge. Numerous cells may be inserted, containing different gases at pleasure, and all exhibit the discharge with equal brilliance. The experiment is, then, a modified form of that of M. Dumoncel, exhausted air being used in the place of air of ordinary density, and luminous currents appearing in the place of sparks. The singular character of these discharges has been investigated successfully by Mr. Gassiot and Dr. Plücker by the use of the magnet. The exhausted air in the neighbourhood of the terminal wires, thrown into a highly inductive state, yields to the tension, and passes onward the electricity by a luminous current to the farthest boundaries of its substance. The glass diaphragm becomes inductively polarized, and the natural electricities of the succeeding gaseous space are divided, part being determined to one, and a part to the other end of the cell, with luminous effects. The same induction and division of electricities takes place in the next diaphragm and cell, until, in an instant, the equilibrium of induction is established between the two terminal wires of the coil. On the subsidence of the impulse inductive polarity disappears, and the natural electricities in the gaseous spaces re-unite with contrary currents to those before exhibited. The returning luminous current, although succeeding the first at an insensible interval of time, is made separately visible to the eye by the use of a magnet, which compels opposite currents to follow opposite sides of the internal tubular spaces of the cells. The successive compartments of the compound tube enclose, under ordinary circumstances, volumes of highly and variously-coloured light; but under the action of the magnet, loops of light, lining the interiors, are seen at each pulsation of the coil. If a cell be drawn at the centre

into a capillary tube, the branches of the loop will neither coalesce nor cross, but may still be traced at this point by a magnifying lens in the form of two brilliant lines most deli-

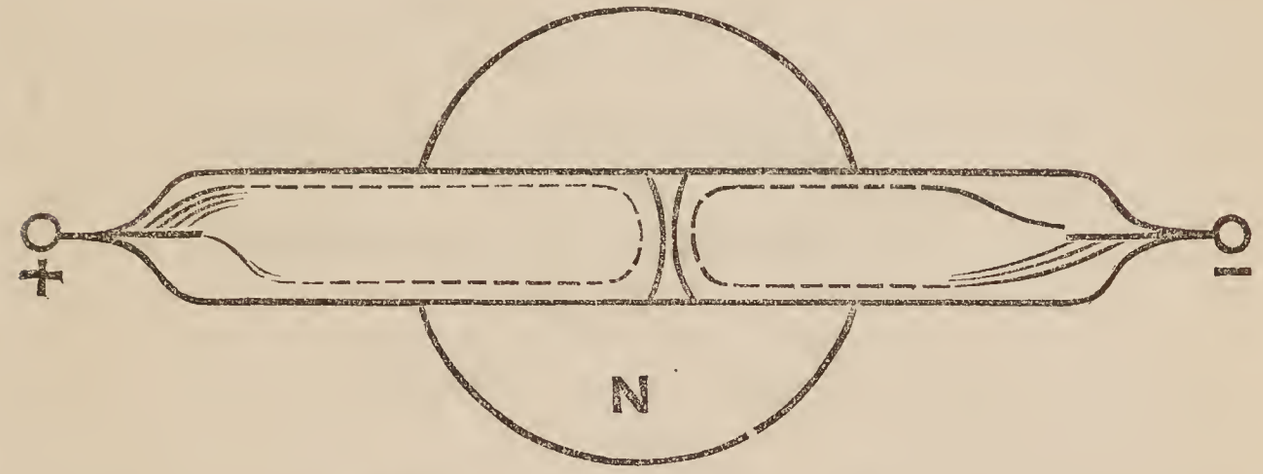


Fig. 1.

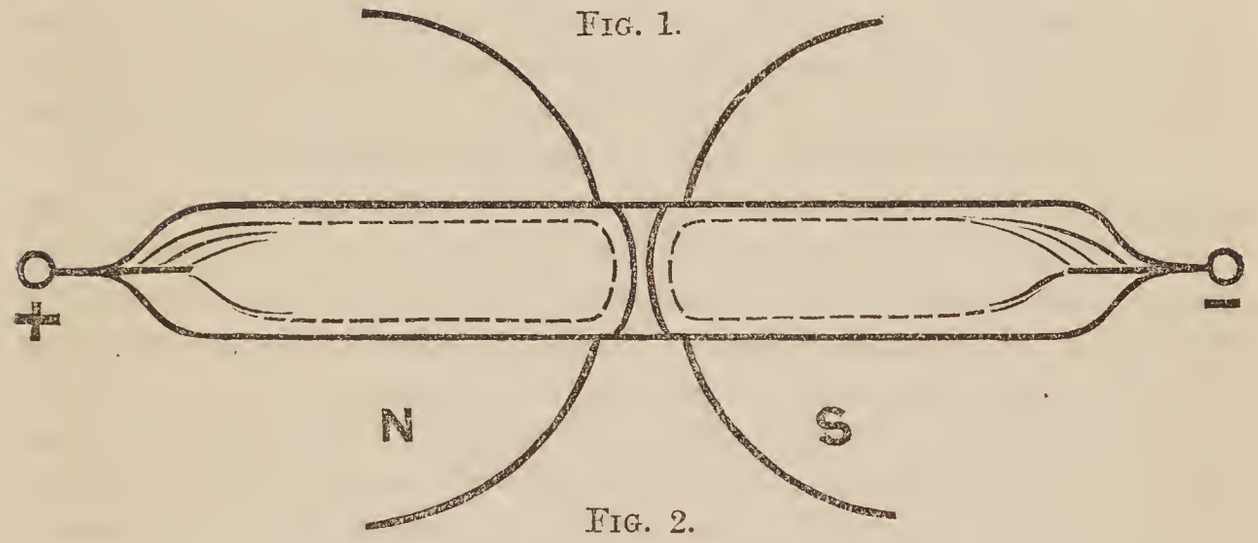


Fig. 2.

cately divided. We here perceive occularly that division and re-union of natural electricities which Dr. Faraday supposed to occur in each isolated particle of a dielectric medium, when such a medium is subjected for a moment to inductive polarization between the excited faces of two oppositely electrified bodies.

It is only when made to cross at the centre of a cell by drawing the halves of the cell over opposite poles of a magnet (see fig. 3) that Dr. Plücker has observed vacillatory effects of the kind before mentioned in the transported current, but momentary suspensions of a current by a magnet, accompanied by sonorous tones, have since been obtained by Mr. Gassiot in certain very similar experiments. Experiments were undertaken to ascertain the degree of exhaustion at which electrical discharge in rarefied air ceases to be luminous and visible. It was observed that disruptive discharge by spark became converted gradually into an envelope of the spark, or diffuse stream, as the exhaustion advanced, and that the stream decreased to a line of very feeble light at one-eighth of an inch

of barometric pressure. This finally disappeared at half a line of pressure of the same standard. The latter degree of exhaustion corresponds, according to the best tables of atmo-

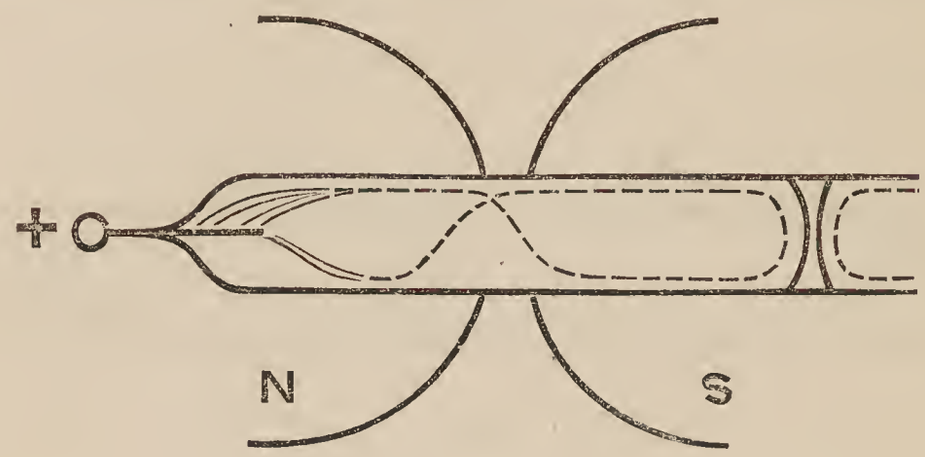


Fig 3.

spheric pressure, to forty-five English miles above the surface of the earth. The occurrence of auroral arches and streamers, of admitted greater altitude, and particularly of shooting stars and fireballs, equally of greater elevation than the limit here assigned, cannot, therefore, justly be ascribed to an electric cause, unless great irregularities of surface and singular upheavals be regarded as not uncommon occurrences in the higher strata of the atmosphere. On the other hand, Professor Plücker draws attention to a marked character of aërial electric currents. In air comparatively dense they obey all the solicitations of the magnet; but in rarer air, or gas, that path is selected by the current least subject to magnetic disturbance, and discharge takes place accurately along the curves of force, emanating from the pole and passing through the point of emergence, for the moment, of the luminous current from the wire. In this particular, such currents closely imitate the appearances common in auroral beams which, springing from all parts of the horizon, constantly appear to converge in a crown or ring to that point near the zenith of the heavens towards which the south pole of a magnetic needle itself directs when the northern pole is free to dip, in obedience to the magnetism of the earth. It thus appears highly probable that the mobility and intermittences in the lower flashes of an aurora, accompanied by vertical propagations of light in the highest branches and streams, will ultimately receive a complete explanation in the combined electrical and magnetical activities of the earth. That a similar explanation will be established for fireballs and shooting stars appears more doubtful.

THE MOTIONS OF CAMPHOR.*

A CHEAP little book has just appeared which suggests scores of interesting observations, that require no expensive apparatus, or unusual skill to perform; we allude to the *Experimental Essays* of Mr. Charles Tomlinson, one on "the Motions of Camphor in Water," the other "the Motion of Camphor towards Light," and the third on the "History of the Modern Theory of Dew." All three are compactly published in one small volume, but it is of the two former only that we now speak. Every one knows that if a piece of camphor is thrown into a clean vessel holding clean water, it commences a series of remarkable movements, which continue for a considerable time. This curious phenomenon has long attracted the attention of scientific men. Mr. Tomlinson's papers give a succinct account of their labours, and of the various theories from time to time put forth. The real explanation seems to be that which he suggests, namely, that "the adhesion of the surface (of the water) constantly detaches from the fragment (of camphor) a portion of its substance, and spreads it out in a film, which film reacting on the fragment, produces reaction after the manner of a Barker's Mill." The Barker's Mill is a contrivance by which an arm mounted upon a pivot rotates, if currents of water or steam move in opposite directions from either end. For the satisfactory exhibition of the camphor motions, it is necessary that the camphor films should be got rid of quickly. This is partly effected by their solution in the water, but still more by their evaporation, and hence a fine warm day, when the latter process goes on quickly, is most favourable.

Among the great variety of experiments detailed by Mr. Tomlinson to make the camphor currents conspicuous, he obtained excellent results by powdering the surface of the water with a layer of lycopodium, and then throwing in the midst of it a little bit of camphor. "The very moment," he tells us, "the camphor touches the water, there is a strong repulsion of the lycopodium, and a clear circular space of water is opened a couple of inches in diameter. Then there is a pause for a moment, when all at once the lycopodium is formed into a number of revolving wheels, arranged in pairs, the two members of each pair revolving in opposite directions, the whole forming a wonderfully beautiful and striking figure." He further tells us that "the number of wheels in a glass four inches in diameter may

* *Experimental Essays*, by Charles Tomlinson, Lecturer on Physical Science, King's College, London. Virtue Brothers and Co.

be four, six, eight, or ten, according to the size and shape of the piece of camphor, and the vigour with which the process is carried on."

Another interesting series of experiments may be made by dissolving camphor in benzole, and throwing a drop of the solution on the surface of perfectly clean water. The drop forms a lens-like body, which, after various antics and motions, splits up into smaller discs, which go through strange contortions, and at last leave a crystalline film of camphor on the water surface.

This last observation may be agreeably varied by the employment of the microscope. The following is the plan we have adopted for this purpose. Take a hollow glass slide* and make it chemically clean, by washing it with a drop or two of hartshorn if grease is suspected, and then rinsing in clean water and wiping it with a perfectly clean cloth. The small cup-like depression in these slides forms an excellent vessel for our purpose. Let one be filled with clean water, which may be taken up for the purpose with the dipping tube. Then bring the microscope body to a *vertical* position, so that the stage is horizontal, and the water has no disposition to run out when the hollow slide is placed upon it. Matters being thus arranged, put a two-inch power on the microscope, and bring the surface of the water into focus, and while looking through the instrument put a minute drop of the camphor solution—prepared as directed below—on the water in the centre of the field. A great commotion will be immediately seen. On the edges of the drop of camphor solution, which will look large under magnification, minute drops will form, exhibiting curious curvilinear motions. Some will dart off, and whirl round and round, during which process spots of crystallized camphor will appear, grow bigger, and finally spread into a film which may be quiet, or put forth prolongations and undergo contortions before repose comes on. Some drops will take amœboid or protean forms, others again will develop long crystalline threads, spreading in various directions, but the end will be the production of a film of crystallized camphor, often assuming exquisite arborescent forms.

The solution may be made by putting a piece of camphor as big as a pea into a two-dram phial, with one dram of *benzine*, now sold by all chemists to clean ladies' gloves. A pin should be thrust into the cork of the phial with the head downwards, to which enough of the solution will adhere when the cork is taken out. It is then only necessary to touch the surface of the water for an instant with the head of the pin, taking

* The so-called hollow slide can be had of all microscopic opticians. It is a plate-glass slide with a rounded depression in the middle.

care not to convey too much. If the solution is of the right strength, the appearances above noted will be seen, or something like them, for they vary each time. If too strong, the film of crystalline camphor will form too quickly, and then a little more benzine may be added. If too weak, the motions will be inconspicuous, and then a little bit more camphor may be dropped in. The observer should particularly notice the changes in the fluid level which the camphor films and currents will produce. The addition of a second or third drop from the pin head will vary the effects.

Mr. Tomlinson's researches lead him to deny the accuracy of the explanations usually given of the formation of camphor crystals in bottles exposed to light. He says, "a bottle of camphor in the dark produces no deposit, even after months of exposure, but when put in a window a deposit forms immediately. One bottle put within another forms no deposit, even though exposed to the diffused light of day. Exactly so. A bottle shut up in the dark is protected from radiation; it is equally warm all round, and though filled with vapour, there is no sufficient reason why a deposit should be made at one part of the bottle more than another. Put that bottle in the window, and it becomes cooled on the side nearest the window pane, and a deposit is made. Light has nothing to do with this result." He adds that he has taken a bottle of camphor out of a cupboard, and obtained a deposit in three minutes by exposing it in a window when the moon was shining. This looks, at first sight, like a confirmation of the light theory, but the same result was obtained when there was no moon.

We must refer to Mr. Tomlinson's book for the details of scores of experiments made with various materials, and in divers ways; but we must quote his opinion on the storm-glass, because he does not seem by any means to have exhausted the curious subject of its indications. He remarks, "as a weather indicator it does not appear to be of much value; it rather follows the weather than precedes it, and seems to depend for its action entirely upon variations in temperature." Admiral Fitzroy, who has been trying experiments with these glasses since 1825, says that nothing could be made of their variations until lately, but that it is now ascertained that if they are fixed undisturbed in free air, out of the way of radiation from fire or sun, the appearances vary in character with the direction of the wind, and with electrical tension. He tells us, as the atmospheric current veers toward, comes from, or is only approaching from the polar direction, this chemical mixture "if closely, even microscopically watched, is found to grow like fir, yew, fern leaves, or hoar frost, or like crystallizations."

As the wind comes, or tends from the opposite quarter, the

regular, hard, and crisp features vanish. Before, or during southerly wind, the mixture sinks and becomes shapeless. Stars indicate easterly winds, produced by a combination of the main currents, while an opposite combination, making west winds, is indicated by clear, liquid, and well-defined crystallizations. Crisp features indicate *plus* electricity in the air; a melting sugary appearance, *minus* electricity. "Temperature," adds the admiral, "affects the mixture much, but not solely, as many comparisons of winter with summer changes of temperature have fully demonstrated."

We have satisfied ourselves that the ordinary directions sold by opticians with storm-glasses are worthless, and we incline from our own observations to think that Admiral Fitzroy is right. The subject is well worth elaborate investigation, and Mr. Tomlinson gives the following formula, the quantities mentioned filling * a larger glass than is usually made :—

Camphor . .	2½	drams.
Nitre . .	38	grains.
Sal ammoniac .	38	,,
Water . .	9	drams.
Rectified spirit .	11	,,

Camphor crystallizations from this solution, or in dry bottles, do not seem to depend upon changes of temperature *only*. The rate at which they take place and the partial manner in which they affect the tubes or bottles, is evidently important, and the electrical state of the air may have its influence as Admiral Fitzroy states, or the result may take place from the alterations in temperature that usually accompany electrical changes, without the latter having any influence in the matter.

The ordinary storm-glasses, covered with a brass cap, may not be quite air-tight. It seems advisable to make some which are hermetically sealed, and others which are closed in the usual way, to see if changes in atmospheric pressure exert any power over the behaviour of their contents.

Mr. Tomlinson says, with reference to the camphor crystals in dry bottles, "the conditions required for the production of fine deposits are warmth to raise the vapour, and cold on one side to condense it." If this be so, it would seem that the bottles under ordinary circumstances only contain enough camphor vapour to supply one side with fine crystals; but if they were made warmer so as to increase the evaporation of the camphor, both sides ought to yield fine crystals, if cooled with the right degree of slowness or rapidity, and to the requisite extent. We do not quite understand what Mr. Tomlinson means by stating as an explanation of why he did not obtain deposits in certain cases, that "a thick glass tube, by exposure to the light, does

* About three-quarters full is sufficient.

not cool unequally, but slowly varies in temperature throughout its mass, so that no deposit either of mercury or of camphor is possible." The unequal cooling can only determine the unequal deposit of the condensed vapour. Equal cooling would cause an equal deposit, if sufficient in extent, and if the previous temperature was high enough to give rise to sufficient evaporation. Obviously the most favourable circumstances for augmenting the deposit would be cooling one side, while the rest of the vessel was warm enough for the evaporation to go on.

FURTHER RESEARCHES ON THE DISSOCIATION OF WATER BY H. ST. CLAIRE DEVILLE.

In a second paper read before the French Academy,* M. St. Claire Deville observes that when one or two kilogrammes of melted platina are thrown into water, an abundant discharge of explosive gases (oxygen and hydrogen) takes place, mixed with a certain quantity of nitrogen, "which is dissolved in the water, and which the heat sets at liberty." "This," as he observes, "is a repetition on a large scale made by Mr. Grove." "How is it," he asks, "that platina fuses so readily under the influence of the temperature developed by the combustion of oxygen and hydrogen, and that platina when melted, or merely heated to whiteness, decomposes water?" To reply to these questions he made certain experiments, which are thus described :— A porcelain tube, five or six centimètres in diameter, was carefully filled with perfectly clean fragments of porcelain, which had been heated to redness. A rapid current of carbonic acid was made to traverse the tube, having passed through a vessel of water at from 90° to 95°C. Lastly, the tube was brought to a high temperature by a furnace supplied with dense fuel, and urged by bellows. A small quantity of the vapour of water was decomposed, and, being collected over a solution of potash, yielded—

Oxygen	46·1	46·8
Hydrogen	35·4	31·9
Carbonic oxide . . .	12·0	10·7
Nitrogen	6·5	10·6
	100	100

Thus the dissociation of water can be accomplished without the aid of the porous tube mentioned in the previous paper,† but the quantity of gases obtained is four times less.

* *Comptes Rendus*, 23rd February, 1863.
† See Intellectual Observer for April.

M. Deville then inquires why the elements of water do not re-unite as the cooling takes place. The first reason he considers to be a physical one, arising from the well-known incombustibility of an explosive mixture scattered through an inert gas, such as carbonic acid or nitrogen. Such a mixture, he remarks, resists the electric spark, and does not inflame on the application of a lighted taper. It cannot, however, he adds, slowly traverse a porcelain tube filled with fragments of porcelain at a red heat without a re-union being effected.

A second physical reason he ascribes to the velocity with which he caused the gases to pass through the tube, and which affected the rapidity of the cooling, and their return to the temperature at which oxygen and hydrogen do not unite when diffused through a large quantity of carbonic acid. Upon this principle he explains the escape of the gases when melted platina is thrown into water. The oxygen and hydrogen, thus dissociated, rise quickly through the water, and become too cold to re-unite, and the resistance to reunion is augmented by the nitrogen shown to be present. In operating with the vapour of perfectly pure water, passed rapidly through a heated platina tube, recomposition followed dissociation, as he considers, because the presence of the inert gas was wanting under these circumstances, and because the considerable latent heat of the vapour of the water prevented rapid cooling.

MOSSES FOR THE MICROSCOPE.

BY M. G. CAMPBELL.

Mosses are divided into two grand sections, the *Acrocarpus*, or *summit-fruited*, so called from bearing their capsules, or fructifications, at the summit of the stem; and the *Pleurocarpus*, or *side-fruited*, thus named because their fructification proceeds from the side of the principal stem.

Of the first of these great divisions, the *Polytrichum formosum* and the *Polytrichum commune* are now putting on their golden calyptras or veils; and though the fruit of either does not ripen till June, they are, even in the present month, conspicuous from their size, and from their gold-coloured hairy veils.

The genus *Polytrichum* may be classed among the tallest and most showy of our native mosses; of perennial habit, and growing in uncultivated places, dry or moist, especially on heaths and in woods. They are distinguished by their pris-

matic apophysate * capsule, and the peristome † in general has sixty-four teeth, rarely thirty-two; are named from πολυς, many, and θριξ, hair; and we notice them first, not only because their appearance is striking, but because the true structure of the sporangium, or spore-case, *i. e.* seed-vessel, and of the columella ‡ of mosses, may be most easily seen by a careful microscopic examination of the unripe capsules of the various species of this genus, where it will be noticed that the columella or central pillar is separated from the spores by the inner portion of the sporangium, and the diaphragm, which is attached to the peristome, constitutes the dilated apex of the columella, the lid being filled up with cellular tissue which seems to have a distinct origin. The peristome, as in other mosses, is a continuation of the inner layers of tissue, composing the theca or spore box, but in some species there are traces of an inner peristome, united into one mass with the outer teeth, while proceeding from the sporangial membrane.

P. formosum has a simple elongated stem, with spreading leaves of a linear-lanceolate form, with a sheathing base, acute, sharply serrated, and plane. The capsule from four to six angled, pale brown, obscurely apophysate; lid conico-rostrate, or conical beak-shaped, calyptra large, stems, when full grown, from three to six inches long, grows in loose tufts, seldom branched. The capsule is oblong, at first erect, but subsequently horizontal. The rostrate lid is half as long as the capsule, or sometimes even longer; the calyptra covers the greater part of the capsule, sometimes quite envelopes it. The teeth of the peristome sixty-four, pale and rather short, while the basilar, or basal membrane, is very narrow, scarcely rising above the mouth of the capsule. Habitat, woods, etc. The writer has found it in some abundance in a damp dell, at the foot of Ferny Hills, Nailsworth.

P. commune so nearly resembles the above as to be sometimes confounded with it, but it may easily be known by the form of the capsule, which in *formosum* is often five or six angled, with a more obscure apophysis, and a longer conical rostrate lid, as well as by the consistence, that of *formosum* being soft, and of a pale fawn colour, while the capsule of *P. commune* is comparatively shorter, acutely four-angled, and distinctly apophysate, with perichætial § leaves, which *formosum*

* An apophysis is a swelling. In this case apophysate means with a swelling at the base of the capsule.

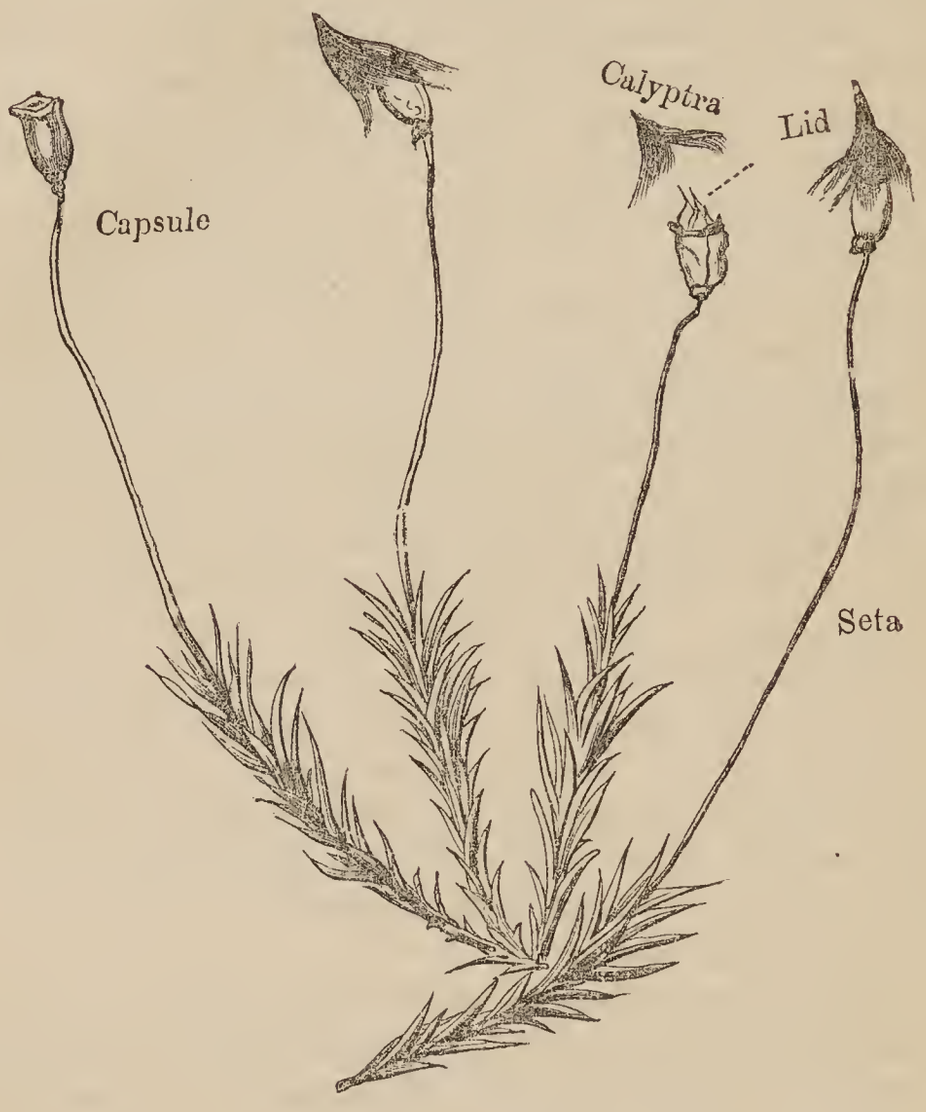
† Peristome, from περι, about, or round about, and στόμα, the mouth; in mosses, the beautiful fringe of teeth at the opening of the capsule.

‡ Columella, the little pillar, or central axis round which the sporules are seated.

§ From περι, around, and χαιτη, the name of bristle. The name is given to the leafy sheath of the bristle or slender stem which bears the capsule of mosses, and is botanically called *seta*.

has not; the calyptra is also larger, and of a deeper, richer colour, orangy, inclining to red.

There are four or more varieties of *P. commune,* one growing in marshy places, and attaining a length of stem from six inches to a foot; another on heaths in drier situations; a third on dry heaths, rarely attaining more than two inches in length of stem. A fourth variety is found on the drier part of moors in mountainous districts, and has branched pyramidal stems; while the ordinary form has only simple elongated stems, with leaves widely spreading and recurvèd, linear-lanceo-



POLYTRICHUM COMMUNE.

late from a pale sheathing membraneous base, serrated, and with bifid or cleft lamellæ at the edges. The seta, or fruit-stalk is reddish, and from two to three inches long; the capsule sharply quadrangular, and of a reddish brown. Most muscologists are agreed as to the distinctive name of this species, but Dillenius gives it the more graphic one of *P. yuccæfolium,* and with him some few of the German writers agree.

The preceding remarks may assist those who are in search of microscopic objects, to discover some of the most beautiful offered by the vegetable world at this, or it may be said, at any

season of the year, and to such as have not yet examined the exquisite loveliness of their form, and the marvels of their economy, the investigation of this minute tribe will open a world of beauty of which, till known, they can form no conception.

In examining mosses, all their parts should be submitted to the most careful scrutiny; the leaves are excellent examples of simple structure; the calyptræ, or veils, are interesting opaque objects, and may be easily preserved, as may also the whole plant, by putting under pressure nicely arranged specimens, and when dried, pasting them on note or letter paper; and if it be desired at any time to see, in its natural freedom, a particular specimen that may not be easily procured, all that is necessary to be done is to place the dried moss in a saucer containing a little lukewarm water, and in a few minutes the spray will drink in enough to enable it to stretch itself at pleasure, and thus the vital phenomena may be observed even after the plant has been kept in a dry state for years, a quality extremely useful in examining some species whose foliage shrivels up when dry.

The capsules should be watched throughout their growth, and especially when the lid falls off, disclosing the exquisitely formed and coloured teeth of the peristome, often in their structure displaying a chiselling and designs that no carved oak can rival. They should be treated as opaque objects, and viewed with an inch objective and a Lieberkuhn, or if the latter instrument be wanting, the illumination can be obtained by a bull's-eye lens. The spores are very small, and those who wish to trace their growth may sprinkle them on a piece of damp stone, covering it with a glass.

The fructification of mosses is more complicated than was formerly supposed. As Dr. Carpenter observes, "the capsule, or urn, is not the real fructification, but its product, for mosses like liverworts possess both antheridia and pistillidia." The antheridia of *Polytrichum* are elongated bodies, producing *sperm cells*, and these, acting on the *germ cells*, give rise to the spore capsules, or urns.

PASTEUR ON INFUSORIA AND FERMENTATION.

M. Pasteur's previous researches on fermentation have been explained in the Intellectual Observer, and we have now to give an account of some fresh investigations, recently laid before the French Academy.*

M. Pasteur commences his narration by adverting to his discovery of an *animal* ferment, the alleged "animal," to which other observers may not so readily concede that title, having the singular property of living entirely without oxygen or atmospheric air, and giving rise to the *butyric fermentation*. He repudiates the formerly accepted chemical theory of the changes that take place when sugar or lactic acid experience that peculiar fermentation, and ascribes it to a species of vibrio, the germs of which are disseminated by the air. Now, he tells us he can adduce a new example of fermentation, namely, that of tartrate of lime, which is determined by an infusorial animalcule, a vibrio, living without free oxygen, but very different, in appearance at least, from that which induces the butyric fermentation.

He places some tartrate of lime in water with a minute quantity of phosphates, earthy and alkaline, including that of ammonia. These salts may be artificial, or contained in the ashes of yeast, or the ashes of infusoria of the same kind. The vessel employed is a flat-bottomed flask with the neck drawn out and united to a curved tube of glass. The flask is filled with pure water after having received the tartrate. The contents are then exposed to ebullition, by immersing the flask in a bath of chloride of colcium, while the curved tube is plunged in a water bath, which is also boiled. By this means the air is expelled. The surface of the water in the vessel into which the curved tube is plunged, is finally covered with a thick layer of oil, and the whole apparatus allowed to cool for twenty-four hours. Under these conditions, the tartrate evinces no disposition to ferment; but if a few of the infusoria resulting from the spontaneous fermentation of tartrate of lime are introduced, they progressively multiply, and the tartrate gradually disappears, giving place to a deposit formed of the carcases of the vibrions, which are about one thousandth of a millimètre in diameter, and of variable length, sometimes reaching the twentieth of a millimètre.

When the water in the flask contains air, a race of monads and bacterium termo appear first, and after they have extracted the oxygen, the vibrions, which assist the fermentation, come into being.

* *Comptes Rendus*, 9th March, 1863.

M. Pasteur remarks that the preceding observations explain how readily fermentation occurs in solutions containing tartrate of lime, unless precautions are taken to exclude germs of the vibrions which excite it. At the surface of the liquid those infusoria multiply which consume the oxygen, and in the body of the liquid others spring up which require no oxygen, and which the former preserve from coming into contact with it.

M. Pasteur observes:—"The experiments described, and the composition of the materials employed, deserve particular attention, when we consider the primary cause of fermentation. Former theories regard the presence of albuminoid substances as indispensable requisites in all cases of fermentation, almost more so than the ferments themselves. According to my view, the *utility* (though not the necessity) of the albuminoid matters is recognized, because they afford a certain aliment to the ferment, the germs of which cannot be developed, and which cannot reproduce itself without the aid of nitrogen and phosphates. Thus there are two kinds of aliment which ferments find in albuminoid substances; but we may suppress plastic nitrogenous matter, if we replace it by a salt of ammonia mingled with alkaline and earthy phosphates. Moreover, it results from the composition of the tartaric liquid, that the sole carbonated element which the ferment can obtain is the tartaric acid which constitutes the fermenting body. We arrive, therefore, at the conclusion that the animalcule borrows all its carbon from the fermentible matter. There is no doubt—if we omit preconceived ideas as to the cause of fermentation—that under the circumstances we are now considering, there is a nutrition of the ferment at the expense of the fermenting matter, and that while the life of the infusory lasts, there occurs a transference of matter from the substance which ferments to that which excites its fermentation. The hypothesis of an action purely catalytic, or one of contact, is not admissible any more than the opinion which I now combat, and which assigns the character of a ferment exclusively to dead albuminoid materials.

Assuredly the fact of the nutrition of a ferment at the expense of the fermentible matter does not explain why the vibrio is a ferment. We know that the ordinary actions of vegetables and animals upon the intermediate principles which nourish them is not associated with fermentation, properly so called. But we must remember, in comparing the creatures previously known with those of which I now speak, that these animalcule ferments present a physiological peculiarity ignored up to this time, since they live and multiply without the presence of free oxygen gas. We are thus led to consider the fact of nutrition accompanied by fermentation, as a nutrition without the consumption of free oxygen. This, assuredly, is the secret of all

fermentation properly so called, and perhaps of many of the actions, normal and abnormal, in the organism of living beings." . . . . "We can now affirm the existence of two kinds of living beings, one demanding the presence of free oxygen, the other which operates without contact with this gas, but which always manifests the character of a ferment. As to the number of beings that can live without air, and determine acts of fermentation, I believe them to be considerable, whether we speak of vegetables, that is to say, of organisms which exhibit no power of self-movement, or of animals, that is to say, of organisms whose motions have a voluntary appearance. I hope to demonstrate, in a subsequent communication, that the infusorial animalcules that live without free oxygen are *ferments of putrefaction*, when this act takes place sheltered from air, and that they are also ferments of putrefaction in contact with air; but in that case associated with infusoria or with moulds (mucors), which consume the free oxygen, and which fulfil the double part of agents of combustion for organic matters, and of preservers of the infusorial ferments from the direct action of the air."

CONSTRUCTION AND SILVERING OF GLASS SPECULA.

BY FREDERICK BIRD.

Reference having been recently made by the Rev. T. W. Webb, of Hardwick, in his able and interesting articles on Celestial phenomena, to silvered glass specula as being applicable to the Newtonian telescope, and far superior to the old metals, and an intimation being given that several amateurs in England were, at the time, engaged in making these specula, of sizes from five up to twelve inches diameter, and that possibly the results of their labours might, in some form, be laid before the readers of the Intellectual Observer—as one of the persons referred to, I have much pleasure in briefly narrating my own experience and the amount of success achieved with specula of this description, at the odds and ends of time saved from other and more pressing duties.

I was first induced to attempt a silvered glass speculum about two years ago, at the urgent recommendation of Mr. Webb, and commenced operations with one nine inches diameter, having a tube, brass cells, and other arranged parts of a telescope by me adapted to receive a speculum of that size. It was formed out of a piece of polished plate-glass, one inch thick, and after being roughly cut from the sheet with a dia-

mond, was finally ground to a square edge, made circular, and fitted accurately into the brass cell. The surface intended for the speculum was then reduced in the usual manner with emery and water, the work being done in my own polishing machine, until the curved surface was brought into agreement with the guage. It was then polished as perfectly as possible.

As all the errors of curvature, and its final perfection, lie concealed in that small quantity of the glass surface which can be removed in the process of polishing, the utmost pains were taken, in forming the polisher, in the selection and application of the materials, and in the careful variation of the stroke, to abrade the surface in such a manner as to generate as nearly as possible the parabolic curve, on which the perfection of the mirror depends.

The results of these labours were from time to time carefully tested by placing the speculum in its tube, and observing, in the most critical manner, the definition obtained of the minute figures and dots upon a watch-dial, placed at a distance of one hundred yards, and also by carefully noting the manner in which the much more minute discs of double and triple stars were exhibited. When no further improvement by the means then at command seemed probable, the surface of the speculum was considered ready to receive its coat of pure silver. The deposit was obtained by suspending the speculum face downwards in a solution of nitrate of silver, with other ingredients, according to a formula discovered by Professor Liebig.

For this important part of the process, I have to acknowledge the valuable assistance of Mr. With, of Hereford.

The bath, containing fifty ounces of solution, for silvering is prepared in the following manner:—

A large shallow vessel of glass or porcelain is provided to contain the solution, and should be wider than the speculum by two inches, and at least five inches deep. One hundred and fifty grains of nitrate of silver are dissolved in six ounces of distilled water; to this is added pure liquid ammonia, drop by drop, until the precipitate which is at first thrown down is redissolved. Two and a-quarter ounces of pure potash, called potassa fusa, are dissolved in fifty ounces, by measure, of rain water, and fifteen ounces of this solution are added to the ammonical solution, when a brown black precipitate is produced. Ammonia is again added drop by drop, until this precipitate is just re-dissolved; twenty-nine ounces of distilled water are then added to the whole. To this mixture is again added, drop by drop, stirring with a glass rod, a strong solution of nitrate of silver, until a precipitate, which does not re-dissolve, begins to be formed.

Previous to immersing the speculum, one part, by weight, of

powdered milk sugar, to ten parts, by measure, of distilled water, must be prepared in a separate vessel, and filtered until a clear solution is obtained. Then to ten parts, by measure, of the silvering solution, must be added one part, by measure, of the milk sugar solution, and, finally, fifty ounces of the compound solution will be sufficient to silver a speculum nine inches diameter. As the success of the process depends greatly on the glass surface being made chemically clean previous to immersion in the bath, the utmost pains need to be taken to accomplish this object. The surface is first covered with thick whiting cream free from grit, and when dry is rubbed off lightly with the purest cotton wool. The surface is then wetted entirely with dilute nitric acid, and afterwards thoroughly washed with distilled water, by pouring over it, and last of all suspended in a flat vessel containing alcohol, where it remains until the bath is ready to receive it.

To facilitate the suspending, a circular block of wood is very firmly cemented to the back of the speculum with marine glue or pitch, and three pins inserted at equal distances round the margin to which the strings may be fastened. On lowering into the bath, care has to be taken that no air-bubble intervene, that the speculum be not deeper in the liquid than half its thickness, and that a depth of two inches, at least, intervene between the face of the speculum and the bottom of the vessel. In ten minutes after immersion a metallic film will be seen forming on the glass, and in an hour or two a compact silver coating will be laid over the whole surface.

The speculum should remain in the silvering bath for four hours, by which time the process is completed; it is then carefully removed, washed with copious applications of distilled water, and placed on its edge to dry.

As the deposit is covered with other matters which accumulate during the process, imparting to the surface when removed from the bath a dull and somewhat dirty appearance, it is necessary to remove these matters by a careful polishing. Fortunately, this may be accomplished without injury either to the curve or to the film, nothing more being required than a soft pad of cotton velvet stuffed with wool. It is first rubbed carefully with the pad alone, and afterwards with the addition of the finest rouge, by which means the surface may be polished to the highest degree of brilliancy, and kept free from scratches. This finishes the entire process.

So excessively thin are these films that they have been estimated not to exceed the twelve-millionth of an inch in thickness, and they are so far transparent as to transmit light through them, which is strongly tinted with a very rich blue colour.

They are also deposited with such extreme evenness and regularity as to assume the precise curvature of the surface to which they are attached, and in no appreciable degree interfere with the defining properties of the curve.

Being anxious to secure the greatest possible quantity of light from the silvered surface, I resolved to adopt the same principle with the small oval reflector, placed in the axis of the tube, to divert the pencil of light from the large speculum into the eye-piece. I made several "flats" of this kind, but finding great difficulty in preserving their figure during the polishing process, I searched, at the suggestion of Dr. Frankland, for pieces of the finest polished plate-glass, and was successful in meeting with some in all respects suitable for the purpose. Pieces were ground into the oval form, and when silvered, possessed the highest reflective properties, even surpassing those of a fine rectangular glass prism, with which I had the means of comparing them.

When the mirrors had been properly adjusted in the tube, their performance was carefully tested on some of the closest of the double stars, and although it was soon perceived that more false light played about the object than was anticipated, or could be detected when the speculum was unsilvered, yet the defining properties were so excellent and the light so magnificent, as to separate, very obviously, any stars not more than one second apart, while the faintest companions, usually to be seen with achromatics of five and six inches aperture, and then only in the finest condition of the atmosphere, were clearly distinguished.

As a few specimens of these objects, may be named 52 Arietis, all the components of which were detected without previous knowledge of its character, the close pair of the triple star ζ Cancri, η cor. Borealis, 36 Andromeda, 72 P II. Cassiopea, ψ Cassiopea, 12 Lyncis, the minute comes adjacent to λ Orionis, the fifth, and on several occasions the sixth star of the Trapezium, all the ten stars of σ Orionis, the clear elongation of ω Leonis, and γ^2 Andromeda, while the moon, planets, and their satellites were shown with the utmost splendour, and with excellent definition.

Since completing the nine-inch speculum, and finding it much less expensive than I had anticipated, I resolved on going a step further, and attempting one twelve inches diameter, which, after four or five months' hard labour, was completed and silvered on the 16th of March last.

It is mounted in a brass cell in an iron tube; has a focal length of eight feet nine inches, and weighs fifteen pounds. Up to the present time no favourable opportunity has occurred for testing its performance fully. At a trial, on the evening it was

silvered, with 13 Messier, a resolvable nebula in mid distance between η and ζ Hercules, the appearance of the nebula, so called, was magnificent in the extreme, the field of view, almost up to its margin, being "powdered with stars innumerable in multitude."

A trial also on η cor. Borealis gave the components widely separated, with admirably defined discs.

I have every reason to believe that this speculum will command all the objects which only large achromatics of eight or nine inches aperture will reach, and if its defining qualities should equal its light-grasping power, I shall feel well rewarded for all the labour and the pains bestowed on its construction.

THE ANATOMY AND PHYSIOLOGY OF GASTROPODS.

THE DIGESTIVE SYSTEM OF THE *GREAT SLUG*.*

BY HENRY LAWSON, M.D.,

Professor of Physiology in Queen's College, Birmingham.

(*With a Tinted Plate.*)

We are too apt, in our zeal to become comparative anatomists, to seek in remote regions for some rare creature to dissect, forgetful of the fact that there are lying around us myriads of familiar beings whose structure, habits, and development are extremely interesting. There are many would-be *savans* who, though quite on terms of intimacy with the arrangement of the internal organs of a nautilus, or ornithorynchus, are lamentably ignorant of the anatomy of a snail, a fly, or a spider; and I do not fear to assert that such individuals have a species of instinctive contempt for the study of the structure of common animals, and would look upon the writer of an article upon the subject I intend to treat of with a feeling akin to horror. The class of persons to which I allude we should not despise, for they merit, if anything, our pity. I purpose in the following pages to give a general sketch of the form, structure, and use of the various organs which collectively constitute the alimentary system in the large black slug of our gardens and fields; but, before doing so, I think it of advantage to offer a few remarks regarding the mode of carrying out our operations, prior to entering upon the descriptive portion of the article. We must not go over the bridge till we come to it. Let us see, then, in the first

* For a more detailed description of the anatomy of this mollusk, consult the author's communication to the *Quarterly Journal of Microscopical Science* for January, 1863.

place, what apparatus we require. There are two things to be done.

First. The dissection of the animal.

Second. The microscopic examination of the dissected parts.

For the first we require some knives, needles, forceps, pins, pairs of scissors, and a small trough. The knives must be of different sizes; those supplied for the use of medical students will answer pretty well, but, if they can be obtained, it will be desirable to purchase a couple of the finer and more perfect instruments employed by ophthalmic surgeons. The form of blade which I have found of great advantage in dissection is simply a curve of steel, whose sharp edge is on the concave border, and which serves to cut away loose connecting bands without injuring the adjacent parts. The needles used must be of two kinds—the ordinary sewing ones and those in vogue among glovers. The latter forms are useful in dividing delicate filaments (*e. g.*, small branches of nerves, etc.), by pressing them against the trough, and which the scissors could not be brought to bear upon conveniently. Both forms should be fixed in solid wooden handles—those to which steel pens are attached will answer admirably, and *not* fitted to the universal handles in which crochet needles are placed. It will be well to bend two or three of the needles into different curves, to be used in looping up flocculent membranes, prior to their division by the scissors. The forceps may be of the kind that is to be found in the dissecting-case; it will, however, be of advantage to have two or three pairs of different sizes, and one also which is bent at the extremity. The pins must be of different sizes, and strong. The scissors should be of three varieties—a plain, long-pointed, *straight* pair; a long-pointed *curved* pair, whose blades are bent about the middle, at right angles to the plane of motion; and a pair of spring scissors, one blade of which is fixed to a long straight ebony handle, and the other acted on by a spring, so that, when passive, the two are separated from each other. The form of trough depends upon the taste of the operator. Some anatomists are accustomed to employ a wooden saucer, the bottom of which has been painted white; whilst others use a shallow white earthenware pan, to the bottom of which is attached a layer of cork. The utensil I approve of most is that recommended by Dr. Carpenter, viz., a square, very shallow box of gutta-percha, which the reader may prepare for himself as follows:—Take a sheet of thin gutta-percha, fifteen inches square, and having softened it in boiling water, turn up each edge at a right angle for about a depth of an inch and a-half, next press the corners together, taking care to make them waterproof, and the trough will be completed. For the microscopic examination we require an instrument of fair power,

of the compound form, and also what is termed a simple microscope. I shall not here enter into the details of the mode of working with these apparatuses, but I would refer the reader to the valuable communication of Mr. Slack in the January number of the INTELLECTUAL OBSERVER.*

Having captured our slug, we put an end to his existence either by the application of ether, or, more simply, by immersing him for a few seconds in very warm water.† Nextly, we place him in the trough, and fix him to the bottom by means of two pins, one of which is driven through the caudal end of the creature, and the other through the fleshy projection beneath the mouth—both being allowed to penetrate the gutta-percha to a very slight extent. Here we see the object of the yielding, soft bottom; if we were to endeavour to carry on our dissections in a soup-plate or pie-dish, we should have no appliance to maintain the *subject* in one position, neither could we, when the organs had been exposed, have any means of separating them from one another.

Now, having arranged our specimen in the proper position, we at first remove the thick tegumentary covering, and the incisions which we make for this purpose will, in a great measure, depend upon the region which we propose to investigate the characters of. In this instance we require to study the digestive system, and we shall make the following incision:—Place the point of the curved knife between the lips of the respiratory orifice, which is situate upon the right side, near the middle lateral line, and about half an inch from the upper tentacle; then, being cautious to avoid damaging subjacent tissues, cut diagonally backward and toward the left side till you have completely divided the smooth black skin which forms the hood; here you will find a very decided stricture formed by bands of fibrous tissue; after a little manipulation, however, you will be able to insert the point of your blade beneath it, and then one slight movement upwards will remove the obstacle, and expose to view the contents of the abdomen. You will now alter the direction of your incision, and cutting in a right line toward the tail you will then perceive the entire abdominal contents as they are placed in the living animal. On making the first incision, the lungs were cut through, and also the bag which contained the shell, the pericardial gland, and the great vessels proceeding from the heart; when the constriction was severed, the fold of membrane separating the heart and heart-gland system from the abdomen was also divided.

* *On the Eye and the Microscope.* By Henry J. Slack, F.G.S.

† Should it, however, be desired to examine the structures closely, and whilst in the possession of their normal character, it will be well to dissect the animal while living, as re-agents of any kind affect the tissues less or more.

The digestive system we can now expose very easily by the aid of our needles and scissors; thus, in the posterior part of the body, we find the liver and intestines closely bound together by blood-vessels, which pass from one to the other, and are adherent to both; we place our curved needle beneath the gut, elevate it a little, and then, with our curved scissors, nick off the arteries, nerves, and connective-tissue fibres which serve to attach it to the liver. In the same manner in the anterior regions we separate the digestive organs from the reproductive apparatus, nervous ganglia, and any loose filaments which remain.

After we have advanced so far, we pour a small quantity of clean cold water upon the specimen, in order to wash away the particles of biliary matter which have escaped from the delicate lobes of the liver, and which so obscure the other structures that a perfect observation is impossible; this fluid we then decant, allowing it to escape over one of the corners of the trough (which we have slightly elevated at the opposite angle), and having filled the vessel with clean water,* we are now in a position to commence our study.

When we have dissected away the skin of the head, we recognize the alimentary system as a long canal, of a brownish green colour, travelling from the head throughout the body, in which it forms many curves and folds, to a small aperture beside the lung opening, where it ends—this latter being called the *anus*. Attached to this digestive tube, and, in fact, part of the entire system, we perceive two glandular structures near the head, a pair of very large brownish glands, which fill the abdomen, and a small sac. The first are the salivary or spittle glands, the second are the two moieties of the liver, and the third is the stomach.

The white, glistening round body, in which the mouth lies, is named the head. That portion of the canal which passes from the head to the stomach is styled the œsophagus or pro-stomach, the remainder being called the intestine.

We have to consider, then, the following organs:—head, œsophagus or pro-stomach, salivary glands, stomach, liver, and intestine.

The head is a solid, white structure, of a more or less spherical form when seen from above, but appearing oval when examined in profile; the large end is behind, and has projecting from its lower border a small, whitish, semi-transparent papilla. It is about a quarter of an inch long from front to back, and one-fifth of an inch from side to side; interiorly

* The water serves to render each organ more perspicuous by causing the soft, flocculent, membranous folds to float, and thus prevent the concealment of underlying parts.

it is hollow, and has two apertures, one by which the food is introduced from without, and another that is continuous with the œsophagus. The anterior one is the true mouth; the cavity which intervenes between the external aperture and the opening of the gullet is readily divisible into two. Cut open the head with your scissors, dividing the upper, and *not* the lower portion, and you will then observe that there is at the back of the cavity a small pouch; this pouch we may designate the pharynx, and call the whole channel above, the mouth. You will find, if you examine the part of the head incised by the scissors, that there is adherent to it a horny, yellow palate, which is of a triangular form, and is bent downwards in front, where it plays the part of a maxilla, and when acting in concert with the fleshy lip, by which the oral orifice is guarded below, can grasp the leaves of plants and such like, which form the staple food of this animal.

The palate, or jaw, which I have just described, is about one-eighth of an inch wide and one-sixth of an inch long, and though attached to the fleshy wall of the mouth's roof above, can be easily detached, and is a pretty object for examination with the lens of the simple microscope. The pharynx, or sac of the mouth, is broad from side to side, and narrow in an antero-posterior direction, flat behind, and angular in front. It is lined with a roughened membrane, and has pointing from it, downwards and backwards, the small whitish teat or papilla which I alluded to above. This papilla projects like the finger of a glove, from the head, and when turned, as it were, inside out, it stands in the pharyngial sac. Now, since both the latter and the papilla are covered with a roughened coating, it follows that when any vegetable substance of a soft nature is placed between the two, and the papilla (or tongue, as it should be termed), moves to and fro, the intervening material will be pulpified. Before we go a step further, let us investigate the features of this membrane.

With a needle and small forceps, I tear a thin, semi-transparent lamina from the surface, place it upon a glass slide, moisten it with caustic potass, and cover it with a square of very thin glass.

Having put on the shallow eye-piece, and two-thirds inch objective, I now lay the glass upon the stage, and I perceive an exceedingly pretty object. The membrane is covered by a multitude of closely-set spines of a calcareous nature (*vide* plate, fig. 7), arranged in linear order side by side, the lines being placed one behind the other; each spine consists of a central portion or body, which is elliptical, and an exquisitely slender curved hooklet springing from this latter; the points of the hooklets all project backwards, and the spines are placed

one behind the other, and *not alternately*,* an exceedingly small rounded process rising from the membrane between every pair.

The functions of the head are two, those of prehension and mastication, deglutition being achieved through the contractions of the gullet. The first, I believe, is performed by the jaw and lip, which by their consentaneous action grasp the leaf, or other portion of vegetable matter, and bring it within reach of the pharynx; arrived here, it is acted on by the saliva, which has been introduced (in a manner we shall see presently) into this sac; then, by a series of complex movements of the tongue, it is submitted to a process of rasping between the hooklets of this latter and those of the pharynx, and eventually, having been reduced to a state of very fine division, it is tilted backwards by the tongue, and being within the reach of the œsophagus, is gradually carried onward to the stomach.

With a Valentin's† knife, I prepare a thin section of the tissue of which the head is composed; this I place on a slide of glass, and having laid it on the stage of the *simple* microscope, carefully tease out a small portion for examination with the higher powers of the compound one. The head is composed mainly of connective tissue, and as this is a form of web with which some of my readers may perchance be unfamiliar, I subjoin here a terse description. It consists of a more or less transparent bed or matrix, portions of which are *falsely* fibrillated (that is, have the appearance of being composed of fibres, although no such *structures* are present), containing in it occasional cavities of an irregular outline, denominated vacuoles, and having scattered through it, sparingly, delicate, curled fibres.

Besides this material there may be found muscular fibres of the non-striated variety in the lower lip, and the tongue is almost entirely muscular from the spinous coat inwards.

The exceedingly loose, lace-like, and delicate organs, which hang like two beautiful white-stalked leaflets from the head, are the salivary glands; they are two in number, and lie, one on each side of the œsophagus during life. Each gland has a length of five-eighths of an inch, measures about a quarter of an inch from side to side, and pours its secretion (the saliva or spittle) into the mouth by a long and narrow duct, which passes from the gland beneath the large brain masses to the head; this latter it traverses, and it opens just above the pharyngeal sac, into which the saliva drops, thus rendering the process of pulpification of vegetable matter less difficult. These glands

* Lebert, in a communication to *Müller's Archives fur Anatomie*, 1846, states that the spines alternate; this I have shown to be an error. *Vide Quarterly Journal of Microscopical Science, loc. cit.*

† An instrument with two blades placed side by side, and which can be approximated or separated by means of a connecting screw. When a portion of an organ is divided by this knife, a delicate section is included between the blades.

are made up of a number of minute lobules, arranged in clusters upon the terminal ramifications of the ducts. Viewed under the microscope (with two-thirds of an inch objective) each lobule appears of an oval shape, filled with transparent fluid, and contains, floating in this latter, many well-marked circular endoplasts (*cells* of the older writers) with nuclei in their interiors, and has attached to its inner edge a delicate twig from the excretory duct. (See plate, fig. 3.) The œsophagus, or gullet—to use a more popular term—is a membranous conduit, or canal, which is narrow at first as it leaves the mouth, but which gradually widens, funnel-fashion, after it has passed the nervous collar, which in this as in other mollusks encircles the digestive track. It is usually of a dark brown colour, this being for the most part due to the presence of a quantity of bile it always contains, and which renders it not unlikely that much of the essential digestive operation is performed here. The œsophagus shows a tendency to conform to a curved arrangement, and in this particular resembles the intestinal division of the apparatus; hence, although at first it is situate centrally and horizontally, we find on its journey to the stomach it undergoes several twists; first, it turns to the left and downwards, and again bending to the right in the medial axis, and equidistant from the head and caudal extreme of the body, it terminates in the stomach. To see the œsophagus, it is necessary to remove the reproductive apparatus which bounds it on the right, the heart, heart-gland, lung, and shell-bag which cover it, and the fold of the intestine which lies on its left border. It is little more than two inches in length, has a calibre of one-sixth of an inch at the cardiac orifice of the stomach, and measures diametrically one-twelfth of an inch as it leaves the mouth. With regard to its histology, the œsophagus has the same structure as the intestine, and, therefore, the examination of the former will suffice for the latter also. Two coats enter into its composition—a fibro-muscular and pseudo-mucous; but neither of these can be detached without injuring the other. I take a slice with the assistance of the Valentin's knife—and here, *en parenthese*, let me observe, that in using this instrument the blades should be previously moistened, and the knife should be gently, but firmly, and in an *uniform* manner, drawn towards the operator, cutting at right angles to the surface—and having selected a portion from under the simple microscope, I place it in the compressorium, and examine it with the two-thirds and four-tenths of an inch successively. It then appears that the outer, or visceral lamina, is composed of two distinct strata of nucleated, non-striated, muscular fibres, crossing each other almost rectangularly, and has blended with these, and pursuing an undulatory course, a few of the delicate, elastic, *real fibres*

of connective tissue. The fibres of the muscular strata leave square spaces between them, which in very thin layers appear as transparent, quadrilateral intervals. The second, or inner lamina, is, one might say, devoid of structure, homogenous, and very difficult to prepare for examination. Most writers assert that it is covered with epithilium (collection of endoplasts); this, however, is not at all the case, no trace of even nuclei can be found; the entire stratum seeming to be a kind of protective glazing thrown out over the external layer.

Next comes the stomach. This viscus seems, in point of size, to be entirely out of proportion to the requirements of the digestive function; it is a small bag of an oval shape, and of a dark brown colour, into one end of which open together the œsophagus and intestine, so that these two appear to be continuous with one another, and the stomach seems but an appended sac. It is placed in the centre of an imaginary line, or axis, drawn from head to tail, lying *not* parallel, but transversely; it is attached by its right extremity to the gullet and intestine, but its left end is free, and lies loosely among the lobules of the liver; below, it rests partly on the foot or fleshy disk upon which the creature crawls, but, being uncovered above, it was one of the first parts seen on removing the integument of the abdomen. It is about half an inch long, five sixteenths of an inch deep, and a quarter of an inch wide. In structure the stomach resembles the œsophagus, and differs from it. It is composed of two coats, an outer-muscular and an inner mucous. The muscular coat contains *three* distinct strata of fibres: one longitudinal, the fibres of which travel round the stomach, starting from the œsophagus, and terminating at the intestine; a second transverse, whose fibres run at right angles to those of the latter; and a third oblique stratum, the fibres intersecting those of the others, diagonally cutting the quadrilateral spaces into triangles. (See plate, fig. 5.) The constituent fibres of these different layers are similar externally to those of the œsophagus, but their nuclei are larger and more distinct. The mucous layer is separated from the muscular by a very thin bed of structureless, transparent membrane; it consists of a collection of oblong endoplasts set endwise; the belt or zone of clear substance constitutes the plasma from which the two coats are developed—the muscular growing out, the mucous in; therefore, the inner lamina is truly exogenous and the outer endogenous; the two corresponding to the two strata of the skin of man, which are similarly separated and developed.*

* For an admirably clear and philosophic disquisition upon this subject, consult Professor Huxley's article on "Tegumentary Appendages," in *Todd's Cyclopædia of Anatomy and Physiology.*

The intestine, or tube which conveys away the excrementatious portions of the food, is structurally but a continuation of the œsophagus; it is of the same width as this latter, as it leaves the stomach, but it gradually tapers till, at its termination in the anus, it measures transversely but one-half, or thereabouts, of its diameter at the pyloric orifice. It is (when removed from the body and extended) about seven inches in length: this seems astounding to any person ignorant of physiology, for it seems strange that a creature so low in the scale of organized beings should possess so long an alimentary canal. It, however, does not surprise the physiologist, who is aware that the intestines of plant-eating animals are invariably prolonged, from the circumstance that it is more difficult to digest vegetable than animal food, and that were there a short gut, the alimentary matter would have passed from the body before it had been deprived of all the nutritious materials it contained. The intestine is so folded and twisted about the other viscera that an enumeration of its relations would only puzzle the reader; sufficient to say, then, that on leaving the stomach it approaches the head; then curves backward toward the digestive sac, and again coming forward, ends by a minute aperture just above the respiratory orifice; it is through this opening that the fæces are expelled, and, therefore, it is properly called the anus. With a description of the liver I shall terminate this outline sketch of the digestive system. This is a most important gland, both in point of size and structure; it is composed of two parts, one on either side of the stomach, which resemble each other closely in size and form. Each half is in profile, like an ovate-lanceolate leaf, with jagged edges, and is built up of several large and small lobes, attached to each other by folds of connective tissue; from the various lobes small ducts travel, and by uniting with others, give rise to a considerable canal, which opens into the œsophagus immediately above the stomach; it is about two inches long, and fully half an inch wide. Every lobe is constituted of a series of still smaller divisions, called lobules. If we prepare one of these latter, and subject it to microscopic examination, we shall perceive that it is divided into a number of small compartments of an irregular outline, which contain numerous endoplasts, some with light-brown contents, and others without nuclei, and, in addition to these, a certain quantity of loosely-floating granules. The ducts which carry away the secretion of bile have *no direct communication with these compartments;* they ramify among them, and, in many instances, become converted into the fibrous tissue which forms the walls of the cavities. (See plate, fig. 4.) It is a remarkable fact that an English physiologist has pointed out the same structure in the liver of

H. L. ad nat. delt.

Digestive System of the Great Slug.

man,* and it seems to show that here, as in the human subject, the function of the gland may not be that of secreting bile *alone*.† The bile, or liquid secreted by the liver, is of a dirty, greenish-brown hue, with a faint odour, and a sweetish, nauseous taste. What its exact use is, it would be difficult to say, ignorant as we are of the function of the gall which our own hepatic organs form.

If the reader has distinctly grasped the descriptions contained in the foregoing pages, he will be in a fair position to begin dissections on his own account, and will then be enabled to perceive that, homely and vulgar an animal as is our common slug, it is yet not so entirely despicable as to be termed (what a lady once expressed to me as her opinion of its structure) *all squash*.

Explanation of the Plate.—Fig. 1.—The complete digestive apparatus of an average individual: *h*, head; *ss*, salivary glands; *g*, gullet; *st*, stomach; *ll*, liver; *i*, intestine; *r*, rectum. Fig. 2.—Ideal section (longitudinally and from above downwards) of the head: *o*, opening of mouth; *p*, pharynx; *g*, gullet; *t*, tongue. Fig. 3.—Clusters of lobules from the spittle gland—magnified. Fig. 4. Lobule of the liver highly magnified, showing how the duct becomes converted into the partitions. Fig. 5. Strata of muscular fibres from the stomach, with a few interblended filaments of connective tissue. Fig. 6.—Schematic vertical section of the wall of stomach; the endoplasts above, the structureless layer in the middle, and the muscular fibre beneath. Fig. 7.—A portion of the spinous membrane of the tongue, much enlarged, and viewed from above.

* *On the Structure, Development, and Function of the Liver.* By C. Handfield Jones, M.D., F.R.S. *Philosophical Transactions*, 1853.

† It is only fair to add that an opinion in opposition to that I have advocated above as to structure, is held by Dr. Lionel Beale, Professor of Physiology in King's College, and one who has given very considerable attention to this subject.

SMOKE-RINGS.

BY W. B. TEGETMEIER.

The phenomena presented by the spontaneous combustion of phosphoretted hydrogen are familiar to most persons who claim the title of Intellectual Observers. The rapid ascent of the constantly enlarging rings of smoke, produced by the combustion of the bubbles of gas, as they escape at the surface of the water, is no less striking than their peculiar property of spontaneous combustion. In the minds of most persons the production of these rings is associated with the peculiar chemical constitution and properties of the gas.

The object of the present paper is to disabuse the minds of my readers of this popular error—to show that the production of these rings is due to mechanical and not to chemical causes—to demonstrate their exact character, and to explain the numerous modes and interesting experiments by which they may be produced.

Firstly—The Production of Smoke-rings. Smoke-rings may be produced by a variety of means. The spontaneous combustion of phosphoretted hydrogen is one of the most interesting modes of demonstrating their production. The instructions given in most chemical works for the preparation of this gas are absurdly complicated and incorrect. I have always found that it may be prepared with great ease and safety by attention to the following directions:—Take a very small thin retort, capable of holding not more than an ounce or an ounce and a half of water; place in this three or four fragments of the sticks of fused caustic potash, each being about half an inch in length: add as much water as will barely cover them, and then drop in a small fragment of phosphorus, about the size of a horse-bean; apply a very gentle heat with the small flame of a spirit lamp, agitating the retort constantly. A pale lambent flame will first appear in the interior, and when this reaches the orifice and burns in the open air, the retort should be placed on the stand with the beak about an inch under water. Care must be taken not to withdraw the flame of the lamp. When the bubbles of gas so produced rise to the surface of the water they inflame, and a dense smoke-ring is formed, which rapidly enlarges as it rises. The bright spontaneous inflammation of the gas, and the production of these beautiful rings, renders this experiment one of the most striking character.

If our readers will turn to the Intellectual Observer, vol. ii. p. 387, they will find the account of a newly-discovered gas, consisting of silicon and hydrogen, which burns in the same

spontaneously inflammable manner, and with the same production of ascending smoke-rings.

There are examples of the production of rings by chemical means, but they may also be produced mechanically. Many practised tobacco smokers have acquired the trick of expelling from the mouth distinct masses of smoke which rise in this form, and a railway engine letting off sudden and separate puffs of steam, as when commencing its motion, not unfrequently produces the same phenomenon on a gigantic scale.

But the most interesting production of these rings by mechanical means has yet to be described. If six ordinary oblong cards, each about three inches by four, are taken and the ends folded down, after being partially cut through, so as to leave a central square, as here shown,

they may with a little dexterity be combined into a very pretty cubical box. Previous to being put together, a circular hole about the size of a fourpenny piece should be cut in one card. If the box so constructed be filled with any dense smoke, such as that from a tobacco-pipe, or by allowing the vapours of hydrochloric and ammonia to enter together—smoke-rings in any number and at any desired rate of succession may be caused to issue from the hole in the box, by the slightest series of gentle taps on one of the sides. Their production in this manner is so facile, and so perfectly under control, that their formation constitutes—if the experiment be performed in a room in which the air is perfectly still—a very interesting and pretty experiment.

So much for the mode of producing these rings. Now let us consider their construction. If the reader has ever observed an ascending column of smoke on a perfectly calm day, he cannot fail to have been struck with the extreme beauty of its form—rising, perhaps, from the summit of one of those tall factory chimneys, now, alas! so smokeless; it ascends perpendicularly, spreading out as it rises, and gradually assuming the form of an elongated convolvulus, or, to use a less poetical and more homely comparison, that of a long funnel. This spreading out is due to the resistance of the air, which is greater, being more concentrated, towards the centre than at the outside. In a miniature form this ascending column may be examined by placing a piece of common phosphorus on a plate under a large bell jar; and I once saw it under peculiarly favourable circumstances;—as a large vessel steaming down the Thames turned into one of the reaches, it so happened that the direction of the river and that of the wind corresponded, so also did the speed of the vessel and that of the wind; consequently the tall column of dense black smoke from the funnel maintained for several minutes its

perpendicular position over the moving vessel, which steamed along under this strange canopy, and looked as though she bore a gigantic palm tree whose top reached the skies.

If the reader can imagine the emission of smoke to be intermittent instead of continuous, it is obvious that this expanding column would be broken up into rings, the constantly enlarging circular form of which would be due to the same cause as that which produces the enlargement of the column, namely, the greater pressure of the air in the centre. That this is the case will be evident on a close inspection of a single ring, when it will be found to consist of a vast number of rapidly rotating circles, arranged on a circular axis. Let the reader imagine a number of common circular bone button moulds, each with a single hole through its centre, strung on a piece of wire, which is then bent in a circular form: this would give a correct idea of the structure of a smoke-ring; and if we imagine further each of these bone moulds rotating downwards and inwards, as the ring rises and expands, the resemblance would be still more complete.

RESPIRATORY ORGANS OF THE TADPOLE.

We have received the following interesting communication from Mr. Whitney, to whose researches on the tadpole microscopic anatomists are much indebted. Although investigations of this kind present many difficulties, the objects are fortunately plentiful, and the changes they undergo may, within certain limits, be postponed at the pleasure of the operator, who can place the tadpoles under more or less stimulating circumstances of food, temperature, etc. We have no doubt many of our readers will pursue the inquiry opened for them by Mr. Whitney, and we shall hope to give them an early account of the result of the labours in which he is at present engaged.

"In the last number of your Journal there appears an article 'On the Examination of Tadpoles,' in which the writer alludes to, and extracts from, a paper of mine published in the *Microscopical Journal* for January, 1862. In justice to your readers, therefore, I feel called upon to explain that the organs described in my paper as 'lungs' are *not* indeed the true lungs (meaning the organs adapted to purely atmospheric respiration), but the internal or *secondary* gills. The true lungs succeed to these.

"In some of our standard works on Comparative Physiology, the existence of *two separate and distinct pairs of gills* (*the one succeeding the other*), during the metamorphosis of the Tadpole, is neither expressed nor implied. Having taken one of these

works as a guide in the commencement of my investigation, I was led into the belief that the organs which succeed to the disappearance of the *external* or *primary* gills are lungs. This supposition was strengthened by observing that the Tadpole may be frequently seen at the surface of the water, rapidly opening and shutting its mouth as if in the act of swallowing air. In the course of investigation, however, I arrived at the correction of this error by discovering a pair of minute tubular sacs, placed abdominally directly below the heart, behind the intestine, and united at their upper and open extremities. These are the true lungs of the future frog, in their incipient, undeveloped state.

"There are, therefore, *three* sets of respiratory organs, the development and vascular arrangements of which, as they appear, exist, and disappear in succession, are most interesting and beautiful—most interesting to watch, most beautiful to see, but by no means easy to investigate.

"Should the writer be enabled to accomplish the task he has proposed to himself, and is now labouring to complete, he may have the opportunity of presenting an illustrated view of the transitional changes in the vascular system which accompany the several stages of this striking and beautiful metamorphosis.

"In referring to the paper which appeared in the *Microscopical Journal*, it will now be understood that the organs there designated '*lungs*' are the secondary, or '*internal gills*,' and that the blood circulating in them is aerated by the oxygen contained in the water that visits them. "W. U. WHITNEY.

"13, *Great College Street, Westminster, April* 11*th*, 1863."

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY CHARLES CHAMBERS.

1863. Day of Month.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		Rain—read at 9·30 A.M.
	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°			inches.
Jan. 1	29·876	49·4	47·4	·93	·341	51·4	34·6	16·8	10, 10, 10	SSW, SW by W, SW.	·005
„ 2	29·589	42·1	37·4	·85	·241	45·3	42·6	2·7	9, 7, 0	W by S, SW by W, SW.	·237
„ 3	29·585	39·1	36·2	·90	·231	45·3	33·2	12·1	9, 3, 1	S, S by W, SW by S.	·008
„ 4	...	...	...	...	...	48·0	36·6	11·4	...	...	·156
„ 5	29·039	45·9	43·6	·92	·299	48·3	40·5	7·8	10, 10, 10	SSW, SSW, SE by S.	·200
„ 6	29·077	42·4	40·0	·92	·264	45·5	36·0	9·5	10, 10, 10	S by W, SE, ESE.	·320
„ 7	29·268	38·0	34·1	·87	·215	42·3	32·8	9·5	1, 6, 2	SW, SE, SE.	·240
„ 8	29·562	40·0	37·3	·91	·240	44·0	33·3	10·7	3, 1, 2	SE by S, S, SE by E.	·013
„ 9	29·722	36·5	37·6	1·00	·243	41·7	27·8	13·9	10, 9, 10	—, SE by S, SE.	·008
„ 10	29·678	37·8	32·9	·84	·206	40·2	28·7	11·5	10, 10, 10	E, NE by E, NE by E.	·006
„ 11	...	...	...	...	...	38·0	36·7	1·3	...	...	·096
„ 12	30·094	36·0	38·1	1·00	·248	44·7	22·3	22·4	7, 10, 10	NE by E, S by E, S by E.	·016
„ 13	29·871	41·1	38·8	·92	·253	42·8	25·8	17·0	10, 10, 1	N, SW by W, SW by W.	·622
„ 14	30·273	38·4	35·4	·90	·225	41·2	35·9	5·3	10, 0, 4	N, NNW, NW.	·051
„ 15	30·417	39·5	34·6	·84	·219	41·3	35·0	6·3	10, 10, 10	NE by N, NE, NE by E.	·008
„ 16	30·268	38·0	35·0	·90	·222	39·7	35·6	4·1	10, 10, 10	NNE, NE by N, NE.	·000
„ 17	30·111	37·1	33·2	·87	.208	44·0	35·7	8·3	10, 10, 10	NE by N, —, W.	·000
„ 18	...	...	...	...	...	48·5	32·1	16·4	...	...	·157
„ 19	29·461	47·3	35·6	·67	·226	49·9	40·3	9·6	8, 7, 10	WNW, W by N, W.	·000
„ 20	29·261	40·3	24·6	·57	·153	43·1	42·4	0·7	3, 4, 3	WNW, W, W.	·048
„ 21	29·722	42·5	33·3	·72	·209	45·3	38·2	7·1	9, 4, 10	W, W by N, W by N.	·010
„ 22	29·766	48·7	44·7	·87	·311	51·5	41·8	9·7	10, 10, 10	SW by W, SW, SW.	·011
„ 23	29·653	48·3	40·5	·76	·269	53·1	48·0	5·1	10, 6, 6	SSW, SW, W by S.	·000
„ 24	29·712	45·9	34·7	·68	·219	49·3	37·2	12·1	5, 5, 7	SW by W, WSW, WSW.	·056
„ 25	...	...	...	...	...	48·7	37·5	11·2	...	...	·000
„ 26	30·204	45·8	40·8	·84	·272	50·7	42·0	8·7	10, 8, 8	SSW, SW, SW.	·000
„ 27	30·175	43·9	31·1	·64	·193	46·3	45·3	1·0	10, 2, 1	WNW, W, W by N.	·020
„ 28	30·464	38·6	32·7	·81	·204	44·8	30·2	14·6	0, 10, 2	SW, SW, S by W.	·000
„ 29	29·820	49·2	43·8	·83	·302	53·3	33·8	19·5	10, 3, 2	SW by S, SW, SW.	·000
„ 30	29·515	49·2	46·5	·91	·331	50·9	46·0	4·9	10, 10, 10	SSW, SSW, SW by S.	·000
„ 31	29·477	45·2	39·1	·81	·256	49·3	45·6	3·7	8, 4, 7	SSW, NW, WNW.	·200
Monthly Means.	29·765	42·5	37·4	·84	·244	...	...	9·5	...	...	2·488

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—JAN. 1863.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																	
12																																	
A.M.	1	17	34	11	26	18	15	10	8	2	20	13	4	16	5	11	16	16	18	20	28	25	15	27	11	23	15	34	6	17	25	23	17·1
	2	18	33	10	29	16	11	10	5	1	22	13	4	10	11	10	16	18	19	22	28	26	17	28	11	23	12	28	5	24	22	17	16·7
	3	17	36	10	32	17	6	10	5	3	24	10	3	10	11	14	18	19	23	23	31	23	20	30	11	23	13	26	7	20	27	12	17·2
	4	26	38	10	29	25	3	12	2	3	25	12	1	7	10	13	20	13	25	30	33	22	20	31	16	22	11	27	6	22	30	13	18·0
	5	23	44	2	27	30	3	6	3	1	19	13	1	7	15	12	20	13	25	25	39	23	23	30	17	17	12	22	5	22	28	12	17·4
	6	27	37	2	20	31	9	7	8	1	20	12	1	5	15	15	16	14	27	20	34	25	20	26	20	15	14	20	5	25	24	11	17·0
	7	27	33	7	21		4	7	9	1	21	10	2	7	17	12	16	12	23	26	37	21	27	32	26	15	20	24	5	26	21	13	17·4
	8	28	36	8	19		2	8	11	1	17	10	1	5	19	19	18		17	25	43	20	22	28	30	14	22	20	3	27	23	16	17.7
	9	30	26	11	15	115	3	3	8	1	27	7	3	7	14	19	16	48	14	22	37	21	25	35	33	11	25	19	3	28	25	15	17·3
	10	27	12	10	17		5	2	9	1	20	6	2	8	10	18	20		19	22	37	23	21	40	31	19	23	18	2	26	24	20	17·0
	11	31	14	13	18	25	9	4	5	3	30	7	3	6	10	13	17	8	21	22	36	23	20	41	31	23	24	19	7	25	27	12	17·6
	12	32	15	9	20	16	7	5	8	2	23	7	5	7	9	17	16	8	24	26	34	23	21	34	34	19	22	15	9	23	29	11	17·1
P.M.	1	35	17	16	18	14	12	4	4	12	22	6	14	7	9	15	19	6	24	30	36	26	23	28	31	18	26	20	15	27	30	11	18·5
	2	35	15	15	17	14	10	6	7	11	25	8	12	9	11	15	20	5	25	30	28	23	22	30	31	15	26	16	13	26	30	13	18·2
	3	33	16	15	14	13	8	7	7	13	25	7	16	10	7	17	20	3	20	26	33	21	21	18	28	16	27	18	12	26	28	16	17·5
	4	37	17	9	12	12	11	8	4	10	25	6	15	6	5	15	23	2	16	22	34	17	18	20	21	14	20	12	9	25	27	16	15·7
	5	34	12	10	15	11	12	11	6	11	25	4	20	5	6	18	21	5	16	17	29	12	23	22	24	14	27	11	8	24	27	15	16·0
	6	33	11	10	12	9	12	6	5	14	25	4	20	4	8	15	19	5	13	14	30	10	21	20	20	15	26	8	7	21	25	14	14·7
	7	34	12	8	11	12	18	9	4	12	22	4	20	6	10	15	20	10	17	14	27	10	25	13	20	16	23	11	6	19	25	11	15·0
	8	36	10	7	16	15	17	3	4	10	16	3	20	7	9	17	20	11	17	16	27	9	25	12	20	16	26	12	7	20	28	11	15·1
	9	38	12	9	18	18	13	7	6	8	16	6	22	6	7	14	20	14	16	19	24	12	19	10	16	15	30	7	11	20	32	9	15·3
	10	36	10	9	17	16	6	10	3	10	16	3	23	6	6	14	18	17	15	21	25	11	27	14	14	16	29	8	17	18	32	7	15·3
	11	37	9	16	12	20	6	12	5	14	15	3	20	6	7	15	19	20	15	24	29	15	25	15	16	20	37	9	19	15	34	10	16·7
	12	34	11	17	15	12	7	10	4	15	12	3	15	3	9	20	20	18	20	21	26	13	29	11	18	16	32	5	15	22	25	7	15·6
Total Daily Movement.		725	510	244	450	459	209	177	140	160	512	177	247	170	240	363	448	285	469	537	765	454	529	595	530	415	542	409	202	548	648	315	16·8

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1863. Day of Month.	Reduced to mean of day. Barometer, corrected to Temp. 32°*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Temperature of Air. Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9.30 A.M.	Daily Range.	At 9·30 A.M., 2 P.M., and 5 P.M. respectively. Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Feb. 1	...	...	...	...	...	48·2	34·2	14·0	...	... ...	·066
,, 2	29·900	46·0	43·5	·91	·298	48·5	39·3	9·2	10, 10, 10	SW, SW, SSW.	·050
,, 3	29·798	44·6	38·5	·81	·251	50·1	46·2	3·9	10, 8, 10	SW, WSW, SW by W.	·098
,, 4	30·137	43·2	40·0	·90	·264	49·5	32·8	16·7	8, 10, 10	SW, SSW, SW by W.	·000
,, 5	30·200	46·8	38·5	·75	·251	49·6	40·6	9·0	10, 3, 9	W by N, W by S, SW by W.	·017
,, 6	30·303	47·4	45·4	·92	·314	50·4	43·7	6·7	10, 9, 10	SW by W, SW, SW.	·000
,, 7	30·177	48·2	44·0	·87	·304	53·0	45·0	8·0	10, 9, 1	SW, WSW, SW by W.	·000
,, 8	...	...	...	...	...	47·4	42·7	4·7	...	... ...	·035
,, 9	30·186	38·5	30·4	·75	·188	43·5	30·2	13·3	1, 4, 3	W by N, WSW, SW.	·000
,, 10	30·198	44·4	39·9	·86	·263	48·5	36·6	11·9	10, 9, 9	SW, SW by W, WSW.	·000
,, 11	30·196	43·6	37·4	·81	·241	47·9	41·1	6·8	10, 4, 3	SW by S, SW, SSW.	·000
,, 12	30·381	43·5	34·4	·73	·217	48·5	39·3	9·2	5, 2, 1	——, NW, NW by W.	·000
,, 13	30·647	38·4	33·9	·85	·213	47·0	27·1	19·9	10, 4, 2	——, ——, E by S.	·000
,, 14	30·592	38·6	32·6	·81	·203	42·9	30·0	12·9	3, 1, 1	E by N, E by S, E.	·000
,, 15	...	...	...	...	...	45·0	30·3	14·7	...	... ...	·009
,, 16	30·620	39·6	27·8	·66	·171	48·0	26·2	21·8	3, 1, 2	ENE, SSW, SE by E.	·000
,, 17	30·589	39·7	32·3	·77	·201	48·3	23·2	25·1	3, 0, 1	NW by N, SSW, SSW.	·000
,, 18	30·468	37·7	34·9	·91	·221	47·6	25·2	22·4	10, 4, 8	W by S, SW, SW.	·000
,, 19	30·391	41·2	41·2	1·00	·275	45·4	29·5	15·9	10, 10, 10	——, ——, ——.	·142
,, 20	30·365	40·4	35·8	·85	·228	44·0	39·0	5·0	10, 8, 10	ENE, ESE, SE by E.	·067
,, 21	30·307	43·0	38·3	·85	·249	48·9	32·3	16·6	9, 8, 8	E by N, S by W, SSW.	·005
,, 22	...	...	...	...	...	47·5	36·1	11·4	...	... ...	·000
,, 23	30·293	44·3	37·9	·80	·245	48·4	32·5	15·9	9, 10, 10	SW by W, W, WSW.	·010
,, 24	30·331	42·7	40·2	·92	·266	46·1	42·5	3·6	10, 10, 10	NE by N, NNE, NE.	·000
,, 25	30·427	43·5	40·3	·89	·267	48·0	32·4	15·6	10, 10, 10	SW, SW, SW.	·005
,, 26	30·358	45·5	35·6	·71	·226	49·0	40·2	8·8	9, 9, 8	SW, SW by W, SW.	·000
,, 27	30·257	47·7	38·6	·73	·252	53·0	43.3	9·7	10, 5, 0	SW, SW by W, SW.	.000
,, 28	30·216	45·2	37·5	·77	.242	52·7	32·2	20·5	10, 4, 2	SW, SW, S.	·010
Monthly Means.	30·306	43·1	37·4	·83	·244	...	...	12·6	...	... ...	0·514

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—Feb. 1863.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Hourly Means.
Hour.																													
A. M. 12	8	15	23	12	26	12	13	6	8	11	10	10	4	4	10	8	2	1	4	5	5	9	7	5	4	8	10	6	8·8
1	6	15	21	10	20	15	17	5	7	12	9	12	2	3	15	5	2	3	4	6	3	7	6	6	5	10	12	5	8·7
2	7	18	21	10	16	17	16	5	8	12	5	11	4	3	11	5	1	4	3	5	3	4	4	5	1	10	11	3	8·0
3	5	19	18	10	17	12	15	5	7	12	5	11	3	3	10	3	1	2	2	8	5	7	3	7	2	12	12	1	7·7
4	9	19	17	11	19	13	14	4	6	13	9	9	2	7	9	3	1	2	2	11	4	7	5	4	3	12	12	2	8·2
5	13	21	16	11	18	10	14	3	7	15	14	7	1	11	5	3	1	4	3	10	6	7	5	5	2	12	11	3	8·5
6	19	23	18	7	16	13	13	6	5	12	10	8	1	16	6	4	1	3	3	10	4	8	5	8	1	12	10	3	8·7
7	21	24	18	10	6	13	12	6	7	18	9	5	2	17	6	3	0	4	3	10	5	6	5	8	1	13	9	2	8·7
8	24	26	15	13	8	7	11	5	6	13	10	1	0	16	8	3	0	5	2	10	6	9	4	7	1	14	11	4	8·5
9	27	24	15	15	10	10	10	2	9	13	11	2	1	25	12	2	1	8	2	14	4	9	8	11	6	16	10	4	10·0
10	26	25	15	22	11	11	12	4	12	14	13	6	0	25	12	7	2	8	2	15	3	12	12	11	11	16	13	4	11·6
11	25	26	18	23	13	10	13	11	10	15	13	7	2	24	16	6	5	9	1	9	5	11	12	11	12	18	14	3	12·2
P. M. 12	16	28	15	26	15	13	14	13	10	15	19	9	12	28	16	9	6	8	4	5	5	10	13	11	13	18	17	2	13·2
1	14	28	16	23	15	12	14	15	9	13	21	6	12	31	22	8	5	12	4	5	11	13	15	10	11	15	20	3	13·7
2	16	25	15	24	14	12	11	19	9	10	21	6	12	28	23	4	9	12	4	4	10	10	14	5	9	16	16	6	13·0
3	17	24	14	18	10	13	12	14	8	9	20	7	6	23	22	5	9	8	2	5	7	12	13	6	7	15	16	12	11·9
4	14	25	14	21	8	11	9	14	6	11	18	4	9	21	23	5	7	7	1	4	9	8	10	5	8	13	16	13	11·2
5	11	26	10	23	11	10	7	10	5	11	9	2	11	25	14	8	4	6	0	5	10	6	5	4	5	10	14	9	9·7
6	14	26	14	23	7	7	6	10	6	11	10	3	8	27	17	5	5	6	1	5	7	5	9	3	7	11	13	8	9·8
7	13	24	16	27	12	11	8	15	7	10	11	4	5	20	13	5	4	6	1	6	6	6	9	6	6	12	12	7	10·1
8	12	22	8	25	9	13	7	12	9	11	11	2	8	22	14	5	3	5	5	7	7	7	7	6	5	14	7	5	9·6
9	15	24	9	28	11	14	7	11	9	12	15	4	3	19	8	3	1	5	7	3	7	7	6	4	4	11	7	4	9·2
10	14	21	10	32	13	14	8	8	11	12	15	3	5	19	6	2	3	5	9	2	8	7	9	6	8	11	5	10	9·9
11	15	22	10	29	11	14	6	6	13	11	17	3	2	13	10	3	1	3	7	3	6	6	5	5	7	10	3	7	8·9
Total Daily Movement.	361	550	366	453	316	287	269	209	194	296	305	142	115	430	308	114	74	136	76	167	146	193	191	159	139	309	281	126	10·0

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1863. Day of Month.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		Rain read 9·30 A.M.
	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°			inch
March 1	...	...	...	...	...	49·4	38·9	10·5	...	... ...	·00
,, 2	29·893	49·4	46·5	·90	·331	55·3	41·0	14·3	10, 10, 9	S, SW by S, SW.	·01
,, 3	29·781	52·6	35·7	·56	·227	60·4	43·3	17·1	0, 0, 0	SSE, SSE, SE.	·00
,, 4	29·633	51·5	41·4	·71	·277	60·4	37·0	23·4	5, 5, 3	—, S by E, S by E.	·00
,, 5	29·651	49·4	41·9	·77	·282	57·3	32·2	25·1	3, 7, 5	S, SSE, SE by S.	·00
,, 6	29·426	46·7	42·3	·86	·286	53·0	42·9	10·1	5, 7, 10	SSE, S, S.	·00
,, 7	29·514	41·1	37·3	·88	·240	48·4	38·2	10·2	9, 10, 10	SSW, S by W, S by W.	·00
,, 8	...	...	...	...	...	45·1	33·3	11·8	...	... ...	·20
,, 9	29·517	37·8	25·3	·64	·157	43·4	29·1	14·3	3, 5, 9	W by N, W by N, NW by W.	·00
,, 10	...	...	...	...	...	43·3	28·2	15·1	...	... ...	·00
,, 11	29·591	35·9	29·0	·78	·179	42·0	32·6	9·4	8, 7, 1	N by E, NNW, WNW.	·00
,, 12	29·216	37·8	36·7	·96	·235	42·3	25·5	16·8	10, 10, 10	SE, SE by E, SE.	·00
,, 13	29·324	41·8	34·2	·77	·215	49·8	31·5	18·3	3, 4, 4	NW, WNW, N.	·00
,, 14	29·363	39·5	32·9	·79	·206	47·8	25·6	22·2	8, 9, 8	—, S by W, SE.	·00
,, 15	...	...	...	...	...	44·3	34·6	9·7	...	... ...	·10
,, 16	29·927	41·1	31·1	·70	·193	45·0	36·0	9·0	8, 10, 9	N, N, N by E.	·00
,, 17	30·194	39·4	30·8	·74	·191	44·5	33·7	10·8	3, 5, 2	NNW, NW by N, NNW.	·00
,, 18	29·950	38·5	25·5	·63	·158	44·7	27·8	16·9	3, 6, 5	—, NNE, NNW.	·00
,, 19	29·983	43·0	32·1	·68	·200	48·9	34·1	14·8	5, 7, 4	NWbyN, NWbyW, NWbyN.	·00
,, 20	29·853	46·9	39·2	·77	·257	55·2	37·1	18·1	10, 5, 10	SW, NW by W, WNW.	·00
,, 21	30·101	45·9	34·7	·68	·219	51·2	43·8	7·4	7, 9, 10	NW, N, N by W.	·00
,, 22	...	...	...	...	...	55·9	30·5	25·4	...	... ...	·00
,, 23	30·400	49·8	41·7	·76	·280	59·0	38·3	20·7	7, 6, 6	SW, WNW, WNW.	·00
,, 24	30·443	52·7	42·0	·69	·283	59·6	38·2	21·4	0, 1, 0	SW, N by W, N.	·00
,, 25	30·462	52·6	42·2	·70	·285	60.7	35·4	25·3	9, 0, 0	SSW, —, W by S.	·00
,, 26	30·305	49·7	38·9	·69	·254	57·6	37·0	20·6	8, 7, 4	W by N, W by N, W by N.	·00
,, 27	30·321	47·1	34·2	·64	·215	53·7	34·8	18·9	2, 9, 7	NW, W by W, W by N.	·00
,, 28	29·913	51·1	36·6	·61	·234	55·9	42·4	13·5	8, 10, 10	WSW, NW by W, W by N.	·00
,, 29	...	...	...	...	...	55·9	47·2	8·7	...	... ...	·00
,, 30	30·005	47·9	40·6	·78	·270	53·1	47·1	6·0	9, 9, 10	NW by W, N by W, NNE.	·00
,, 31	30·219	43·2	32·7	·69	·204	49·7	39·7	10·0	10, 3, 1	SE, E by S, E.	·00
Monthly Means.	29·879	45·3	36·2	·74	·235	...	...	15·3	...	... ...	0·6

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER—MARCH 1863.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
12																																
A.M. 1	10	10	8	3	1	4	19	11	7	1	5	1		3	2	14	14	4	3	6	27	3	6	4	2	6	7	15	15	11	12	7·8
2	10	4	9	7	2	8	19	10	8	0	4	1		1	2	15	13	5	5	5	26	1	6	4	2	9	10	15	13	14	15	8·1
3	11	5	10	8	2	7	17	9	5	1	5	3		1	1	16	16	5	6	6	25	2	6	5	1	7	9	15	16	8	15	8·1
4	13	5	7	7	1	6	16	8	6	1	5	5		1	4	17	15	6	7	7	24	2	4	4	2	6	4	18	17	10	14	8·1
5	11	9	8	6	3	8	11	11	4	1	5	6		1	3	19	14	5	5	14	23	4	7	3	1	7	4	20	21	11	13	8·6
6	14	2	7	7	2	11	11	10	5	0	5	5		0	2	14	13	4	5	11	21	3	5	4	3	5	3	17	10	9	12	7·3
7	18	7	9	7	1	14	10	10	4	1	7	8		1	4	19	13	1	12	14	22	2	8	3	2	7	4	18	15	8	11	8·7
8	18	15	9	3	3	15	9	10	6	1	8	15		1	2	20	12	2	12	16	22	2	7	3	1	7	5	19	17	9	13	9·4
9	15	18	10	2	1	19	6	13	6	2	10	15		1	4	21	16	2	12	17	22	3	7	4	1	11	10	16	17	11	12	10·1
10	19	19	15	1	1	22	11	17	5	3	10	16		1	4	25	19	1	14	18	20	5	5	5	2	15	12	20	18	10	10	11·4
11	27	23	15	0	12	29	12	15	4	2	14		3	8	5	26	18	2	19	19	23	4	7	6	2	15	14	28	20	11	10	13·1
12	25	21	15	6	12	31	12	20	7	3	13		4	17	10	25	21	5	17	10	21	8	8	6	4	17	13	28	27	8	8	14·1
P.M. 1	28	24	18	8	12	25	12	19	5	6	10		5	19	10	25	18	4	16	22	18	6	12	6	5	17	15	28	21	8	10	14·4
2	23	35	18	7	14	29	14	20	8	9	11		6	20	10	22	17	6	14	22	17	9	8	7	5	19	15	26	23	7	10	15·0
3	19	24	17	9	15	29	13	12	5	7	9		5	18	11	24	19	6	14	25	17	8	13	8	3	17	17	25	24	7	11	14·4
4	18	21	16	8	15	33	13	16	2	5	15		5	15	15	23	19	10	13	26	12	9	12	6	5	15	18	24	19	8	14	14·3
5	18	22	13	12	13	27	11	16	3	4	15		4	11	10	22	16	7	10	21	11	8	14	6	2	19	16	21	19	9	13	13·1
6	14	19	10	11	7	23	10	18	1	5	6		4	9	3	22	9	6	5	21	6	6	7	4	3	13	15	23	18	6	15	10·6
7	12	12	9	9	2	18	9	21	0	6	5		1	4	6	16	5	5	3	21	5	5	5	4	5	8	15	21	16	18	15	9·4
8	14	8	10	4	6	18	10	20	1	5	5	220	2	4	8	18	3	2	5	23	6	4	3	5	7	10	10	18	11	17	15	9·1
9	11	6	9	3	2	18	6	16	1	3	5		2	2	9	14	3	3	3	21	4	4	5	5	4	12	11	21	9	16	12	8·0
10	10	9	7	2	4	23	1	18	1	5	5		2	3	8	15	3	5	4	32	3	6	3	1	4	17	11	22	11	15	10	8·7
11	8	9	5	1	4	19	6	11	1	4	6		3	2	13	15	4	6	7	20	3	9	5	1	5	18	13	20	10	18	9	8·5
12	6	8	3	0	4	18	12	15	0	4	2		2	1	12	15	3	5	4	18	1	6	5	1	5	11	15	17	10	15	7	7·5
Total Daily Movement.	372	335	257	131	139	454	270	346	95	79	185	343		144	158	462	303	107	215	415	379	119	168	105	76	288	266	495	397	264	286	10·6

ASTRONOMICAL NOTES.

PLANETARY SYSTEMS AMONG THE STARS.—ECLIPSES.—PLANETS OF THE MONTH.—TRANSITS OF JUPITER'S SATELLITES.—OCCULTATION.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

PLANETARY SYSTEMS AMONG THE STARS.

The assertion so frequently made, and so generally accepted, that our sun is one of the fixed stars, is of course incapable of demonstration. Its probability seems to rest chiefly upon two arguments—that the light of the stars is evidently of the same intrinsic and self-developed character with that of the sun, and that the sun, if viewed at a distance equal to that of the stars, would undoubtedly appear no otherwise than as one of them; and since no more direct proof can be obtained, we are willing to receive these as sufficient. But this point once admitted, it is evidently consistent with all analogy to proceed a step further, and to suppose that these other suns, or at least the insulated ones, may be, as our own, the centres of light and heat and gravity, and electrical and chemical influences, to groups of surrounding worlds. The idea is a magnificent one, and in full accordance with every other declaration of the glory of God in the heavens, and it would be no matter of surprise at any time if observation were to give us direct evidence of its truth. Nor would it necessarily follow that the highest class of instruments would be required for the detection of these planetary systems, though so wonderfully remote in the depths of space. Analogy may point the way in many cases where it ought not to interpose a check, and the diminutive size of our planets in comparison with their ruler affords no adequate inference that in other systems a very different arrangement may not obtain. It was a noble expression of old Bianchini's, "Quis unquam exhaustas dixerit cœli copias!" and all the subsequent progress of astronomy has proved, from more comprehensive premises, the justice of his conclusion.

And thus, although planets no larger than our own might ever remain invisible at the distance of the fixed stars, it is not merely possible, but may be even probable, that bodies of a similar nature may be connected with other suns, of sufficient magnitude to be visible with our instruments, especially in their modern state of improvement. The idea was thrown out by Sir J. Herschel, many years ago, that certain very minute points, closely associated with larger stars, may be visible by reflected or planetary light; and he specified among others, ι Ursæ Majoris, γ Hydræ, κ Geminorum, and the *comites* of α^2 Cancri

and a^2 Capricorni; but it does not appear that these suspicions have been verified, or that the matter has been subsequently investigated, notwithstanding its obvious interest and importance.

The subject, however, has been brought afresh before us by M. Goldschmidt's recent assertion that, with an object-glass of little more than four inches aperture, he has not merely perceived Alvan Clark's companion of Sirius, which has hitherto been supposed to be reserved for the largest and most perfect instruments, but has detected five additional companions of the same character, at somewhat greater distances, varying from 15″ to 1′; and, in announcing this discovery, he suggests an inquiry as to whether the object discovered by A. Clark may shine by native or reflected light, which may of course be extended to the rest. It seems remarkable that the colossal telescopes of Clark, Bond, Lassell, and Chacornac, in which the nearest of these alleged attendants has been perceived, should have given no indication, as far as has hitherto been stated, of the other five; but no doubt immediate attention will be paid to so interesting a point. M. Goldschmidt has distinguished himself as the discoverer, with comparatively very inadequate instrumental means, of no less than fourteen of the small planets intervening between Mars and Jupiter, and has, on that account, received one of the most honourable of testimonials, the Gold Medal of the Royal Astronomical Society,* so that not a shadow of suspicion can be attached either to his eye or his judgment; but it is perhaps possible that some source of deception may exist in his instrument, such as appears to have given rise to the supposed satellite of Venus in the last century. We shall soon, at any rate, know more about it. Should the existence of these minute points be established, the most natural supposition, of course, will be, that Sirius is accidentally projected on a background of small stars at an incalculably greater distance; and this idea would not be negatived by any apparent general displacement, which would be referred to the proper motion of the large star. Should, however, any mutual change of position be detected among the *comites*, a wide field would be opened for research among the fortunate possessors of competent telescopes. The question of native or reflected light would of course be a difficult one to deal with—its solution would, in fact, be impossible in the case of orbits highly inclined to our line of vision; but if bodies exist whose revolutions carry them from side to side, or nearly so, with respect to the central luminary, any periodical variation of light connected with their positions in

* Thirteen only had been discovered by him at the date of the presentation, February, 1861. Another was added in the following May.

their orbits would, as indicating the existence of phases resulting from reflection, give sufficient evidence of their planetary nature.

ECLIPSES.

A considerable solar eclipse, in the afternoon of May 17th, will begin at 5h. 42m., Greenwich; 5h. 41m., Cambridge; 5h. 37m., Oxford; 5h. 26m., Liverpool; 5h. 18m., Edinburgh; 5h. 13m., Dublin. From these data such of our readers as may wish to observe the first contact may make a sufficient approximation to the time at their respective situations. The magnitude of the eclipse varies from 0·286 of the sun's diameter at Dublin to 0·349 at Edinburgh. A partial obscuration of this kind is not calculated to exhibit any remarkable phenomenon, though the projection of the rugged lunar mountains upon the vivid background of the sun may be interesting. In a large partial eclipse, 1793, September 5, Schröter and his assistants saw most evidently, with reflectors of 7 and 13 feet, but especially the latter, the globular form of the moon, as indicated by a feeble gray illumination of about 1′ in breadth, gradually fading inwards from the limb. This was, however, more probably an illusion arising from the dazzled state of the eye, than, as Schröter supposed, a result of refraction through a lunar atmosphere.

Our readers may be reminded in time that there will be a total lunar eclipse on June 1; the penumbra, or gradual enfeebling of the moon's light by the partial interposition of the earth, will begin about 8h. 49m.; the first contact with the actual shadow will occur 57m. afterwards.

PLANETS OF THE MONTH.

Mercury may now be looked for in the evenings with a fair prospect of success; its greatest elongation from the sun takes place on the 19th, when it also attains a N. declination of more than 25°. Its diameter at that time will be about 8″.

Venus will be, as she has been for some time, more beautiful to the naked eye than interesting in the telescope; her distance, though diminishing, being still comparatively considerable, with a diameter increasing from 12″·6 to 15″·8 through the month; and the form of her disc, about three-quarters enlightened, not being especially pleasing.

Jupiter will be very conspicuous, and the changes in the belts, and the disturbances in the equatorial region, may be studied with great advantage on so broad a disc, whose diameter decreases during the month from 41″·2 to 38″·8.

The ring of Saturn is undergoing a temporary diminution in breadth, in consequence of the direction of the earth's annual

motion; but the decrease will soon terminate, and be succeeded by a rapid opening during the winter months. The N. side is the one now visible, and as the sun is rising steadily above its plane, an evident shadow is cast on the opposite side upon the globe, or *above* it, in an inverting telescope. A good instrument will show a trace of the principal (or Ball's) division. The satellites will be objects of interest; but amateurs should be careful not to be deceived by the neighbourhood of small stars, which may readily be mistaken for them; as, on the other hand, allowance is to be made for the frequent invisibility of one or more in front of or behind the body of the planet. $3\frac{3}{4}$ inches of aperture will probably bring out, in favourable weather, the five old satellites, but they will require to be carefully looked for. They will not, under present circumstances, deviate much from the general direction of the ring, and the smallest three of those five (*Rhea, Dione,* and *Tethys*) will never lie very far from the ends of it, their greatest elongations being respectively 9·6, 6·9, and 5·4, if the radius of the planet is assumed as unity. *Titan,* the largest, reaches a distance of more than 22 radii, and *Japetus,* the second in brightness, but the outermost in order, upwards of 64.

The variable light of this satellite in different parts of its orbit, being brightest when W. of Saturn, and the irregularity of that variation, were discovered by Cassini. Schröter found the three smaller ones likewise variable, but in a reverse direction; and a suspicion of the same kind crossed my own mind last year with regard to *Titan.* The possessors of powerful telescopes have now a favourable opportunity for studying these curious, though minute phenomena.

TRANSITS OF JUPITER'S SATELLITES.

May 5th, the shadow of II. leaves the disc at 9h. 24m.—6th, I. emerges at 9h. 40m., followed by its shadow at 10h. 14m.—12th, the shadow of II. enters at 9h. 28m.; the satellite, at that time on the disc, will leave it at 10h. 34m., followed by the shadow at 11h. 58m.—13th, I. will be in transit from 9h. 14m. till 11h. 27m., its shadow from 9h. 55m. till 12h. 9m.—19th, the shadow of III. will pass off at 9h. 18m.; II. will enter at 10h. 23m., its shadow at 12h. 3m.—20th, the transit of I. begins at 11h. 1m.; of the shadow, 49m. later.—26th, III. finishes its transit at 9h. 34m., its shadow not entering till 10h. 49m.: II. enters at 12h. 43m.—29th, I. passes off at 9h. 29m.; its shadow at 10h. 27m.

One 6-mag. star only will be occulted during the month, 60 Cancri. May 23rd, 11h. 37m.

PROCEEDINGS OF LEARNED SOCIETIES.

BY J. W. TEGETMEIER.

CHEMICAL SOCIETY.

Artificial Formation of Benzoic Acid.—A paper was read on this subject by Mr. A. H. Church, who, in the course of some experiments on the action of sodium-amalgam upon chloride of phenyle, had obtained some very interesting results. Chloride of phenyle is first prepared by acting upon benzole with a chlorinating mixture of hydrochloric acid and bichromate of potash. The chlorinated body thus formed is a mixture, chiefly consisting of chloride of phenyle and the hydrochlorate of that compound, and when acted upon by a hot alcoholic solution of potash, yields ordinary carbolic (or phenic) acid—

$$C_{12}\,H_5\,Cl + KO,\,HO = KCl + C_6\,H_5\,O,\,HO.$$

From the carbolic acid thus formed may be made sulphophenic acid, and then sulphophenate of baryta. This salt, dried and mixed with half its weight of cyanide of barium, yields (in very minute yet unmistakeable traces) cyanide of phenyle, also called benzonitrile: the reaction is as follows:—

$$C_{12}\,H_5\,O,\,BaO,\,2SO_3 + Ba\,Cy = 2\,(BaO,\,SO_3) + C_{12}\,H_5\,Cy$$
$$(C_{12}\,H_5\,Cy = C_{14}\,H_5\,N).$$

Benzonitrile, boiled with potash, is resolved into benzoate of potash and ammonia. Mr. Church proved the identity of the carbolic and benzoic acids, formed as above described, with the usual states of these substances.

Analysis of the Red Chalk of Hunstanton.—A paper was read by Mr. A. H. Church on "The Composition of Red Chalk." The colouring matter of the chalk is sesquioxide of iron, which sometimes amounts to as much as thirty-six per cent. in the darkest and hardest nodules. Mr. Church considered that the absence of sulphuric acid in any form from the chalk itself, and from the water percolating through it, negatived the idea of a pyritic origin for the iron-oxide. If the proportion of iron-oxide to carbonate of lime be not greater than 4:9, strong ignition of the finely-powdered mineral yields a very dull olive-green substance, to which Mr. Church gives the formula, $3\,CaO,\,Fe_2\,O_3$—a ferrite of lime, which may possibly be of some value as a cheap and indestructible green pigment.

Atomic Weights of Nickel and Cobalt.—Dr. Russell has added another to the elaborate researches into the equivalent numbers of these two closely-allied metals: he comes to the conclusion that they are identical. The numbers obtained were:—

Cobalt 29·37.
Nickel 29·369.

A new Derivative of Formic Acid.—The law of "homologous series" announced by the great chemist Gerhardt, is constantly aiding the discovery of new and interesting organic substances. Dr. A. W. Hofmann has succeeded in obtaining one of the missing terms of what is called the *formic* series, by a simple and usual process. Formic ether, $C_4 H_5 O, C_2 H O_3$, is saturated with ammonia gas, and heated for some time in a closed tube to the boiling-point of water. Formiamide and alcohol are thus produced:—

$$C_4 H_5 O, C_2 H O_3 + N H_3 = C_2 H O_2, H_2 N + C_4 H_5 O, HO.$$

Formiamide is ammonia, in which the complex group or radicle formyle, $C_2 H O_2$, occupies the place of one atom of hydrogen, thus:—

$$\text{Ammonia } \left.\begin{matrix} H \\ H \\ H \end{matrix}\right\} N. \qquad \text{Formiamide } \left.\begin{matrix} C_2 H O_2 \\ H \\ H \end{matrix}\right\} N.$$

Formiamide is an oily liquid, which may be distilled *in vacuo* without change. We may best show the typical importance of this new body by a table indicating its relations to the formic and acetic series. These series being homologous, it will be seen that the three formulæ of the lower line differ from the three over them by $C_2 H_2$:—

ACIDS.	AMIDES.	NITRILES.
Formic Acid $C_2 H_2 O_4$	Formiamide $C_2 H_3 O_2 N$	Formonitrile $C_2 H N$
Acetic Acid $C_4 H_4 O_4$	Acetamide $C_4 H_5 O_2 N$	Acetonitrile $C_4 H_3 N$

April 16.

Dyes from Naphthaline.—A paper was read by Messrs. W. H. Perkin, and A. H. Church, "On some Derivatives of Naphthylamine." Like the base aniline ($C_{12} H_7 N$) the analogous base naphthylamine ($C_{20} H_9 N$) yields several beautiful colouring matters. One of these, discovered by the authors in 1856, they have now submitted to a more complete examination. It is a crystalline substance of a deep crimson colour by transmitted light, and having a brilliant green metallic reflection. It melts at 136° C. It is made by dissolving in water two equivalents of hydrochlorate of naphthylamine, and adding to the solution one equivalent of nitrite of potassium, and one of hydrate of potassium, dissolved in another portion of water. The red precipitate thus formed is purified by recrystallization from alcohol. In accordance with its mode of formation and apparent constitution, very numerous analyses of this product led to the formula $C_{40} H_{15} N_3$, which may be thus represented—

$$\left.\begin{matrix} C_{20} H_7 \\ N''' \end{matrix}\right\} N \qquad \left.\begin{matrix} H \\ C_{20} H_7 \end{matrix}\right\} N$$

two equivalents of naphthylamine joined together by the substitution of one equivalent of nitrogen for three equivalents of hydrogen.

The salts of this base, named "azodinaphthyldiamine," present a most exquisite and rich violet tint, which is shown whenever an acid is added to the base in solution, which itself is of an orange-red colour. The authors describe various hydrochlorates, sulphates, etc., presenting many interesting characters. The basic hydrochlorate, for instance, occurs in golden-brown quadrilateral prisms, which are very beautiful when viewed under the microscope in polarized light. The base itself, as precipitated from its solution by water, is a splendid scarlet powder.

The authors have obtained many interesting derivatives of azodinaphthyldiamine. Among these is a second base, obtained by the action of hydrogen on the original substance. Its chief character is the peculiar blue-green colour which it assumes when oxidized. Messrs. Perkin and Church have also obtained "benzoylazodinaphthyldiamine,"

$$\left.\begin{matrix} C_{20}\,H_7 \\ N'' \end{matrix}\right\} N$$
$$\left.\begin{matrix} C_{14}\,H_5\,O_2 \\ C_{20}\,H_7 \end{matrix}\right\} N$$

and a still more complicated product whose name is worthy of record, if for no other reason, on account of its singular length, "azodinaphthyldicitraconamic acid."

LITERARY AND PHILOSOPHICAL SOCIETY OF MANCHESTER.—*March* 5.

(MATHEMATICAL AND PHYSICAL SECTION.)

In illustration of the abnormal character of the season, two barometric curves, neatly laid down on engraved forms by Mr. Sidebotham, from observations made by him at Ashton-upon-Mersey during the months of January and February last, and a summary of meteorological observations taken at Thelwall by Mr. Atkinson, F.G.S., during the month of February, were communicated to the Section. The mean height of the barometer at Thelwall for February, reduced to 32° Fahr., and to mean sea-level, had the unusually high value of 30·218 inches; the mean temperature was 42·5°; and the total fall of rain was only 0·811 inches. Mr. Baxendell communicated a table which he had calculated, showing the monthly sums of the oscillations of mean daily temperature at Greenwich during the thirteen years, 1848—60; and also the mean daily values for the different months. The mean monthly results were as follows:—

	°		°
January	102·8	July	82·8
February	84·9	August	78·4
March	83·4	September	72·3
April	90·6	October	84·4
May	83·9	November	94·5
June	87·3	December	107·1

The curve laid down from the above numbers differs considerably

from that of any other element of temperature, the principal maximum of disturbance occurring in December, and the principal minimum in September; and it is perhaps worthy of remark that the course of this curve appears to bear a well-marked relation to the annual progress of the growth and decay of plants, the period of maximum disturbance of mean daily temperature corresponding with that when the vital principle in plants is least active; and the time of minimum with that when the ripening of the more important cereals and fruits takes place. Mr. Baxendell also drew attention to the attempt which is now being made to organise an association for the systematic observation of variable stars, according to the plan described by Mr. Knott in our last Number. The recent results of spectral analysis tend to show that the light of the sun has a general resemblance to that of the class of stars to which nearly all the known variables belong, and thus give additional weight to the probability that it may also be slightly variable. Professor Clifton made a communication, in which he endeavoured to show that the principles of the mechanical theory of heat afford an explanation of phenomena attending the production of light by bodies, either when this production of light is due to incandescence or to fluorescence. His remarks and explanations were illustrated by a series of highly-interesting experiments.

Dr. Joule's Sensitive Thermometer.—Dr. Joule exhibited an exquisitely sensitive air thermometer, capable of being affected by the $\frac{1}{1000}$ of a centigrade degree of heat. The construction is thus described:—A glass vessel in the shape of a tube, two feet long by four inches in diameter, is divided longitudinally by a blackened pasteboard diaphragm, leaving spaces at the top and bottom, each little over an inch. In the top space a piece of magnetized sewing needle, furnished with a glass index, is suspended by a single filament of silk. It is evident that the arrangement is similar to that of a bratticed coal-pit shaft, and that the slightest excess of temperature on one side over that on the other must occasion a circulation of air, which will ascend on the heated side, and after passing across the fine glass index, descend on the other side. It is also evident that the sensibility of the instrument may be increased to any required extent, by diminishing the directive force of the magnetic needle. I purpose to make several improvements in my present instrument; but in its present condition, the heat radiated by a small pan, containing a pint of water heated 30°, is quite perceptible at a distance of three yards. A further proof of the extreme sensibility of the instrument is obtained from the fact that it is able to detect the heat radiated by the moon. A beam of moonlight was admitted through a slit in the shutter. As the moon (nearly full) travelled from left to right, the beam passed gradually across the instrument, causing the index to be deflected several degrees, first to the left and then to the right. The effect showed, according to a very rough estimate, that the air in the instrument must have been heated by the moon's rays a few ten-thousandths of a degree, or by a quantity, no doubt the equivalent of the light absorbed by the blackened surface, on which the rays fell.

MICROSCOPIC SOCIETY.

The annual *soirée* of this Society was held at King's College on the 8th April, when a large company was assembled, and a great display made of first-class instruments and objects. Mr. Ross exhibited a considerable number of objects with binocular and single microscopes in a very splendid way. Messrs. Smith and Beck did the same, and introduced two important novelties, the one a new object-glass of $\frac{1}{20}$ inch focal length, and the other a binocular apparatus as a substitute for single lenses in microscopic dissections, the examination of large objects, or any delicate operation for which the watchmaker's or engraver's eye-glass is usually employed. The new $\frac{1}{20}$th was exhibited with the 3rd and lower eye-pieces upon a Podura scale, giving with the former a power of 3,000 linear, and, so far as we could judge under unfavourable circumstances, accurate definition. An $\frac{1}{8}$th, showed by the same firm, with a third eye-piece, left nothing to be desired, either for light or definition. The new binocular dissecting lens, or whatever it may be called, is an admirable invention. It bears some resemblance to a pair of spectacles mounted upon a stand, so as to permit its adjustment to any height. The two lenses are ground so as to act like corresponding portions of a single lens of large dimensions; and as every one knows that a common pair of spectacles produces fatigue and inconvenience which is not felt on looking through the large magnifying glasses used for viewing pictures or engravings, the superiority of the new instrument will be understood when we say that it bears a close resemblance to the effect of the latter, except that the vision is easier and more perfect. Messrs. Powell and Lealand won universal admiration by showing the cell rotation of the Valisneria with their $\frac{1}{25}$ inch object-glass. As Dr. Carpenter observes, this wonderfully perfect glass displays the movements of the protoplasm, which are not visible by ordinary means, but which, having been once seen and understood by the operation of the $\frac{1}{25}$, may probably, we should think, prove amenable to much lower powers properly employed. With this $\frac{1}{25}$th the field is as light and the definition as perfect as that of any large object seen with a 2-inch glass. Messrs. Horne and Thornthwaite made a very interesting miniature scene, by exhibiting the electrolytic crystallization of the new metal Thallium under an excellent microscope; and Mr. Farrants showed an exquisitely-written Lord's Prayer, surrounded by a border of ornamental lines, executed with Mr. Peter's writing machine. Mr. Burr exhibited a section of the leaf of the *Welwitchsia mirabilis;* Dr. Miller showed the *Conochilus volvox;* and Messrs. Crouch, Pillischer, Murray and Heath, and many others, contributed to an extremely interesting display.

ROYAL ASTRONOMICAL SOCIETY.—*April 10th.*

Mr. E. J. Stone read a paper on the Parallax of the Sun, as determined from observations of Mars at the opposition of 1862. The usually received value of the Sun's Equatorial Horizontal Parallax is

8″·57, but M. Leverrier has recently stated that it must be increased, and his examination of the Solar Tables gives 8″·95 for its value. Mr. Stone has discussed the observations of Mars made at Williamstown, Victoria, Australia, and Greenwich, and from twenty-two separate determinations between August 25th and November 12th, 1862, obtained a result of 8″·977, with a probable error of 0″·032. The Astronomer-Royal stated that he had been favoured by M. Otto Struve with the result obtained by M. Winnecke from the discussion of the observations of Mars at Pulkowa and the Cape of Good Hope, which gave 8″·96 for the Sun's Parallax, a value so remarkably accordant with the two others that it was clear we must consider the Sun as three or four millions of miles nearer to us than we had hitherto done. Mr. Airy then proceeded to give an oral account of the observations on Stellar Spectra made at the Royal Observatory, describing the apparatus, and showing a diagram of the spectra observed. The line F of Frauenhofer was generally seen indicating iron in most stars, the sodium line D in two, and a line nearly, but not quite coinciding with G in many. The star α Orionis appeared most like our sun, but generally the stars seemed not to be so complex in constitution. Mr. Huggins inquired whether the diagram showed all the lines observed, or only the principal ones, as in his researches, which had been communicated to the Royal Society, he obtained with, as he thought, more delicate apparatus, more delicate results. The star Capella, which in the Astronomer-Royal's diagram had only two bars, he had observed to be full of fine lines, and seemed to resemble the Sun very closely, as also did Aldebaran. Sirius had lines C and B strongly marked. He and Dr. Miller had photographed the spectra of Sirius and Capella, with a view to the relation which existed between the heat and the extent of invisible rays. Mr. Carpenter, the observer at Greenwich, stated that more lines were seen in the spectra, but only the measured ones inserted in the diagram. M. Otto Struve, after some introductory remarks by the Astronomer-Royal, described a curious anomaly in the earth's effect on a plumb line in the neighbourhood of Moscow. It was found by M. Schweitzer, Director of the Observatory there, that a difference of 8″ in the latitude existed between that element determined by direct observation and by triangulation from distant well-known points; and by observations at very numerous stations in the neighbourhood, it was found that a line existed to the south of Moscow where observations of all kinds agreed, but that to the north there was a difference in one direction, and to the south in another; and that in the direction of the meridian the tract of country affected seemed about seventy-four miles in extent, but that in the line of east and west the extent was greater, and had not yet been reached. The effect was that plumb lines at the two extremes converged one-fiftieth part less that they should, and the only explanation which could be given was that a large trough of the earth was less in density than the surrounding country, as there were no mountains nor large surface of sea to disturb the general effect of gravity, as those features were sometimes known to do.

ENTOMOLOGICAL SOCIETY.—*March* 2.

The Stingless Honey Bees of America.—Mr. Smith, the president, read a memoir on the species of bees found in the New World. Except the European honey bee, *Apis mellifica*, which had been introduced and naturalized in America, no species of Apis occurred in that large continent. But their place was supplied by stingless bees of the genera Trigona and Melipona. The honey collected by these bees varies very much in quality; and from an examination of their mouths, Mr. Smith was of opinion that the different species selected their honey from different species of flowers. We may remark that the yellow coloured variety of the European bee, known as the Ligurian bee, has been recently introduced in the United States, and is spreading rapidly.

ANTHROPOLOGICAL SOCIETY.—*April* 7.

On a Small Human Brain.—Dr. Gore furnished an account of the smallest adult human brain on record. The brain of the adult male averages forty-nine ounces; in females the average is forty-three and a half ounces. The female, whose brain was described, was forty-two years of age, and without any symptom of disease. She was five feet high, and her intellect was infantile. The brain without the membranes weighed ten ounces five grains, being the smallest mature brain on record.

ROYAL INSTITUTION.—*April* 17.

Fertility of Fish.—Mr. Frank Buckland delivered a lecture on the artificial culture of fish, by permitting the ova to develope in shallow boxes supplied with a constant flow of water. Mr. Buckland has recently ascertained the amount of ova in several species of fish, by counting the number in a given weight, say ten or twenty grains, and then weighing the entire roe. The following are the results:—

Salmon, to each pound the fish weighs, about	1,000	ova.
Trout of one pound weight	1,008	,,
Herring of half pound weight	19,840	,,
Perch of half pound weight	20,592	,,
Jack of four and a half pounds weight ...	42,840	,,
Mackerel of one pound weight	86,220	,,
Sole of one pound weight	134,466	,,
Brill of four pounds weight	239,770	,,
Turbot of eight pounds weight	385,200	,,
Roach of three quarters of a pound weight	480,000	,,
Cod of fifteen pounds weight	4,872,000	,,

NOTES AND MEMORANDA.

Mr. Glaisher's Ascents.—The ninth of these incidents took place at the Crysta Palace on the 31st of March, at 4h. 16m. p.m., the temperature being 50°. At one mile elevation the temperature was 33½°; at two miles, 26°; three miles, 14°; three miles and three-quarters, 8°. Then a warm current was encountered, and the temperature rose to 12°. At four miles and a-half, temperature zero. In descending, 11° at three miles; cold current entered, and it fell 7°. At two miles, rose to 18½°; 25½° at one mile, and 42° on reaching earth. The air was dry before leaving the earth; at heights above two miles very dry; exceeding four miles dew point fully minus 40°. This, with previous ascents, shows that the theory of a decline of 1° for each 300 feet elevation must be abandoned. At one mile the deep roar of London was heard distinctly, and a murmur at greater elevations. At three and four miles views were wonderful, extending to Margate, Dover, Brighton, Yarmouth, etc. Railway trains looked creeping things, like caterpillars, and all the country looked so calm as to appear artificial. Looking downwards, patches of cumulus cloud appeared resting on the earth, and had the aspect of shining wool. The blackness creeping over the land at sunset was remarkable, while the sun was still shining on the balloon. The tenth ascent was made on the 18th of April, when he found sensitive photographic paper did not colour as much in half an hour in the full sun at three miles' elevation as in one minute at Greenwich. He likewise made spectroscope experiments, and reports that at four miles, and upwards to four and a-half, "when the light entered the slit from the sun itself the lines in the spectrum were innumerable; all those I saw before leaving the earth were visible, and many more. The nebulous lines (H) were both seen, and the spectrum a good deal lengthened at the violet end; at the red end (A) was visible. When the light came from the sky in the immediate vicinity of the sun, the spectrum was shorter, but all the lines were visible from B to G. On passing from the sun the spectrum shortened very quickly, and when opposite to the sun there was no spectrum—in fact, no light at all."

Dr. Wallich's Amœba.—Dr. Wallich obtained from Hampstead Heath an amœba not previously known as British, and resembling one found by him in Lower Bengal, in which "the villous portion of the ectosarc constitutes a means of permanent attachment to foreign bodies, such as confervæ and the like." The "villous patch" of those from Hampstead occupies from one-fiftieth to one-seventieth of the entire superfices, and is employed as a prehensile organ. The true pseudopodia do not seem to be projected from this area. In some specimens the contractile vesicle presented a reticulated appearance, probably from the occurrence of minute vacuoles. Size of large specimens, 1—50″. Dr. Wallich observes, "several circumstances render it probable that it may be a transient phase in the life history of the common amœba." This amœba is described in *Annals of Natural History*, from which we have extracted the above.

Embryogeny of Comatula Rosea.—Professor Wyville Thompson communicates to the Royal Society observations on the above subject. After complete segmentation of the yelk, a more consistent nucleus appears in the mulberry mass still contained in the vitelline membrane. The external portion of the yelk liquefies, and is absorbed into this nucleus, "which gradually assumes the form of the embryo larva, a granular cylinder contracted at one end, and girded with four transverse bands of cilia. This cylinder increases in size and transpareney, and at last bursts through the vitelline membrane. Several changes take place, and the larva assumes somewhat the form of a kidney bean, the mouth answering in position to the hilum. It swims freely in the water, with a swinging, semi-rotatory motion, by means of its ciliated bands and posterior tuft of cilia." Ten minute calcareous spiculæ are then developed imbedded within the external sarcode layer of the expanded anterior portion. They are arranged in two transverse rings of five. They expand into ten plates, which at length form a trellis enclosing a dodecahedral space. Simultaneously with these plates, from seven to ten calcareous rings are developed, forming a chain passing from the base of the posterior row of plates backwards, and "ending by abutting against the centre of a large cribriform plate, which is rapidly developed close to the posterior extremity

of the larva." This formation finally becomes the jointed stem of the pentacrinoid stage. "After swimming freely for a time, 'averaging from eight hours to a week,' the larva becomes sluggish, and its form is distorted by the growing crinoid." The mouth and alimentary canal of the larva disappear, the stem lengthens, the rudimentary arms are seen, and at some stage of this process the creature becomes attached. Further details in *Proceedings of the Royal Society*, Vol. xii., No. 54, p. 426.

Artificial Production of Fibrin from Albumen and Gluten.—The *Proceedings of the Royal Society*, No. 52, contain an important paper by A. W. Smee, jun., on the above subject. He finds that fibrin can be produced by the direct action of oxygen on albumen, and that "gluten dissolved in gastric juice, and then oxidised at the ordinary temperature, yields fibrin."

78th Planet.—*Astronomische Nachrichten*, No. 1408, contains a letter from Dr. R. Luther, of the Bilk Observatory, announcing the discovery by him, on the 15th of March, of the 78th planet, which he names Diana. It is of the 10th magnitude.

More Companions of Sirius.—M. H. Goldschmidt informs the French Academy that he has been able to see Alvan Clark's companion of Sirius, at intervals, with a telescope of 46 lines aperture. He also observed several other minute stars from 15″ to 1′ from Sirius. One of these, which he says is without doubt a companion, is south of that discovered by Clark: angle of position, 95°—97°. This he found visible "*pour moments.*" A second star on the line between Sirius and A. Clark's companion, was an almost imperceptible point of light. East of Sirius, and of companion No. 1 F, he finds another little star, No. 3 D; and he adds, "the star, No. 4 E, has an angle of position of 170°, and No. 5 of 25° to 30°, and are distant from Sirius in the proportion of (*par rapport de*) No. 1."

Star Spectroscopes.—The *Astronomische Nachrichten*, No. 1408, contains a description of an apparatus made by Steinheil for examining and measuring star spectra, which appears more convenient than that of Jansen used by Secchi. One of the new pattern was forwarded last autumn to the Hon. G. Lettsom, British Envoy at Monte Video. Two other spectroscopes are described in *Cosmos*, which offer the advantage of *direct* vision. The one, used by Amici in 1860, composed of two prisms of crown glass, having one prism of borosilicate of lead between them; the other made by M. Hoffman, of several prisms of flint glass, compensated by several prisms of crown.

Large Concave Mirrors.—In the *Supplement to the Practical Treatise on Optical Instruments*, by Andrew Pritchard, published in 1850, it is stated that a burning mirror was exhibited to the British Association, formed of a circular pane of plate-glass, three-sixteenths of an inch thick, and three feet and a-half in diameter. This was fitted to a cast-iron box one inch deep. Air was extracted from the box, and the atmospheric pressure on the glass pane gave it the necessary curvature, and it was then able to reflect and converge enough heat to ignite various articles and roast meat. Such a mirror, silvered by Liebig's process, as in telescope mirrors, might be useful for many scientific purposes, as, for example, experiments on the heat of the moon.

Physiology of the Stomach.—Dr. Pavy gives a simple physical reason why the stomach is not destroyed by the solvent power of its own gastric juice. He says that in a state of health the blood is always alkaline, and the gastric juice acid. The introduction of food into the stomach causes an influx of blood to that organ, as well as determines a secretion of gastric juice, and he conceives that the alkalinity of the former fluid protects the stomach from the action of the latter.

Black Rain in Scotland.—On March 14, at half-past eight p.m., black rain fell at Blackford, near Auchterarder, Perthshire. A minute quantity of the deposit, dried on a microscopic slide, exhibits a few angular silicious particles, a multitude of exceedingly small dark particles, without structure, and some fibres of vegetable appearance, but nothing distinctive that we could make out.

HORNBILLS.

1.—Buceros convexus.

2.—Buceros bicornis.

3.—Buceros rhinoceros.

4.—Buceros cassidix.

5.—Buceros ruficollis.

THE INTELLECTUAL OBSERVER.

JUNE, 1863.

THE BUCEROTIDÆ, OR HORNBILLS.

BY ALFRED R. WALLACE, F.Z.S., F.R.G.S.

(*With a Coloured Plate.*)

The Zoological Society having recently obtained a living specimen of an adult female hornbill (*Hydrocissa convexa*) from Borneo, furnishes us with the occasion to give some account of these curious birds, which are very seldom to be seen alive in Europe, and are even considered great curiosities by residents in the countries they inhabit.

The hornbills are large and clumsy birds, seldom adorned with bright-coloured plumage, but in many cases bearing a really prodigious bill. In this respect they somewhat resemble the toucans, with which they are often confounded, though they have in fact little or no affinity or true relationship with them. While the toucans are strictly confined to the tropical parts of America, the hornbills inhabit the tropics of the Old World, being found in Africa, India, and the Indian islands. It is in this latter region that the greatest number of large and remarkable species are to be found; and having had frequent opportunities of observing them in their native haunts, I shall endeavour to give a correct idea of their form and habits in the Malay Archipelago, to which will be added a few words on their relationship to other birds and on their geographical distribution.

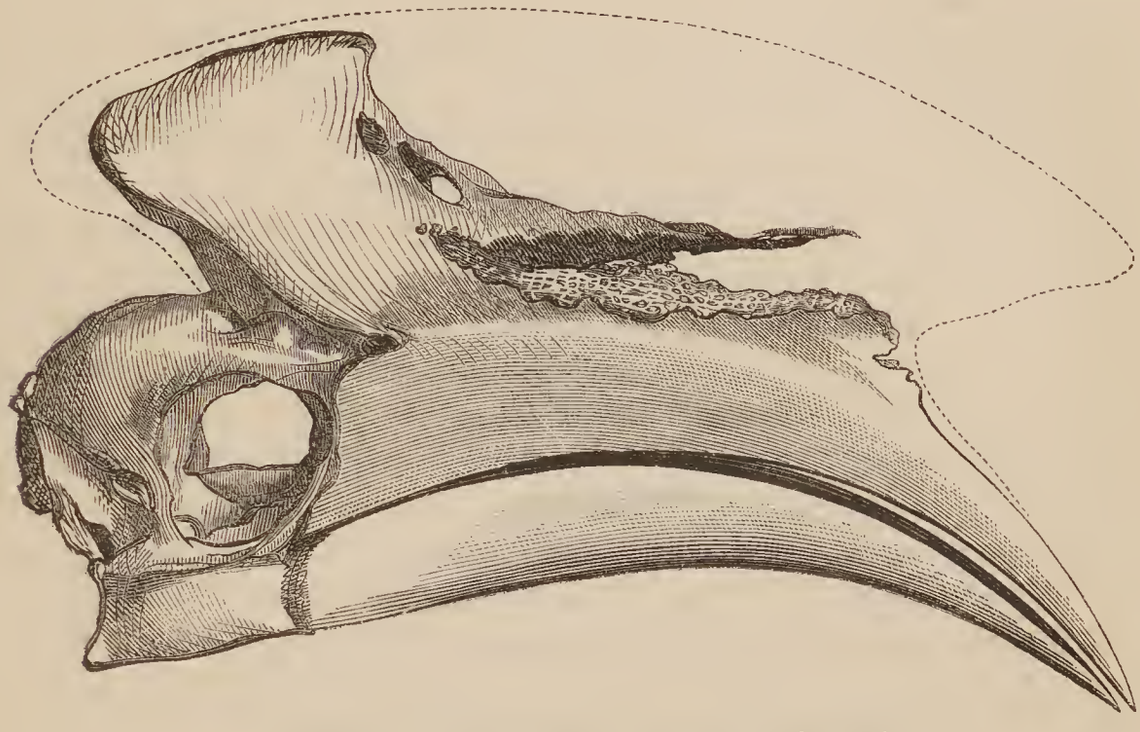
Form and Structure.—Hornbills are generally characterised by large and heavy bodies, rather long and powerful wings, very short legs, long neck and tail, and enormous bill. The plumage in all the larger species has a ground colour of black, sometimes tinged with bronze, and the tail and lower parts more or less varied with white. The neck is very often of a reddish-brown colour; the plumage is generally loose, and on the head and neck often approaches hair in its appearance. In some species the cheeks and a part of the neck is bare, and

adorned with brilliant colours. One of this kind, the *Buceros cassidix*, is figured in our plate. The feet are very remarkable, the three toes in front being joined together for some distance from the base, so that they cannot be spread open as in most birds, but form a broad sole to the foot, indicating that the feet are used merely to rest on, and very little for progression. They resemble on a very large scale the feet of a kingfisher, which, as every one knows, rarely or never hops, contenting himself with sitting still, and using his wings when he wants to move.

But the most remarkable feature of the hornbill is that from which they take their name—the bill. The form of this organ varies in every species, varies often in the sexes of the same species, varies even in the same bird from youth to age; yet there is a certain characteristic form, of which all the others seem to be modifications. It is always considerably curved, rather broad and angular at the junction of the two mandibles, and compressed above and below, generally forming a sharp keel along the top. This is the shape in many of the small African and Indian species, forming the genus *Tockus* of naturalists. Other species have the keel raised at the base of the bill, or have ridges on the sides which meet and form rings or crests at the top. In others again the keel is much elevated, swollen, and projecting in a point above the bill itself, till in the larger and more remarkable species a large boss or recurved horn rises up above the crown of the head almost as large as the true bill itself. In some of the African hornbills a curious modification occurs, in a sort of tube or cylinder open at the front, on the top of the bill. In those species which bear ridges on the sides or top of the bill the number of these is supposed to indicate the age of the bird; whence all hornbills are called by the Dutch in the east, and after them by the Malays, "Year-birds." In the *Buceros ruficollis*, figured in our plate, this rule will most likely apply at least for the first seven or eight years, as the young birds have no ridges, and others are found with all intermediate numbers up to about nine, after which the end ridges seem to scale away and become indistinct, so that it is not improbable the bird may live much longer than this would seem to indicate. In the great rhinoceros hornbill (*Buceros rhinoceros* of Linnæus) the bill attains perhaps its greatest size and beauty, the rich hues of orange crimson and ivory white with which it is adorned in the living bird being scarcely capable of imitation. It is this bird which excited the wonder of the early voyagers to Ceylon (where a variety of it exists), who believed it to have two heads—a statement which was long credited in Europe, and which may serve to teach us that the wildest and most improbable fictions of

early ages had probably a foundation in some curious natural phenomenon.

In this immense mouth is situated a very small tongue, so small and capable of so little motion that it may almost be considered rudimentary, and resembling much the tongue of a kingfisher. The bill itself is very light for its size, though containing a tolerably compact core of porous bone to its very extremity. The horn, however, adds scarcely anything to the weight of the bill, being completely hollow, except at the base,



SCULL OF HYDROCISSA CONVEXA (MALE).
(*The dotted line shows the outline of the bill.*)

where it has a bony core. The rest is merely an expansion of the thin horny sheath of the bill. Another remarkable peculiarity is that the upper and lower mandibles seldom meet, except at the base and tip, all the middle portion gaping from an eighth to a quarter of an inch apart. The only use of this anomalous structure which I can conjecture is that it enables the birds to carry a considerable quantity of fruit in the closed bill (the roof of both upper and lower mandibles being hollow), without crushing it, as they would be likely to do during the exertion of flying if they were obliged to hold the fruit by the pressure of the partly separated mandibles. This would render probable the truth of the singular fact stated by the Rev. J. Mason in his work on the "Natural Productions of Burmah," and probably communicated to him by the natives, that when the female of *Buceros bicornis* is sitting on its nest (in the manner to be presently described), the male brings her a continual supply of fruit; "but all must be unbroken, for if a fig or any other fruit is injured, she will not touch it."

A striking peculiarity of some of the Indian hornbills is, the remarkable difference between the two sexes. In birds generally the bill is a very constant organ, and its slightest modifications are often characteristic of distinct genera. The sexes of many birds differ much in plumage, while the bill remains almost always the same. Here, however, the principal differences between the male and female bird are in the bills, the plumage remaining unchanged, or only offering differences in the colours of the head and neck. For example, the *Buceros ruficollis* (see plate) has the neck rich brown in the male, but entirely black in the female. In the black Malayan hornbill (*Hydrocissa Malayana*) the male has the bill pure white, with a very high keel projecting forward in an acute edge, while the female has it jet black, with a much lower keel of a different shape. These birds have of course been described as two distinct species, and are still thought to be so by some naturalists. I had, however, myself the good fortune to shoot a number of them on the same tree, all the black-billed ones proving by dissection to be females, and all the white-billed ones males. The young of both sexes have the bill white, and I have one female specimen in which some of the white of the young bird is left in patches on the black bill. In the species now living in the Zoological Gardens (represented in the upper figure of our plate), the male has the bill of quite a different shape and colour, and may well be taken for a different bird. In the very young birds the bill is quite simple, without any sign of the horns—in some cases resembling that of a young kingfisher, in others that of the small hornbills with a simple curved bill.

Habits of the Hornbills.—Considered as a whole the hornbills seem to be omnivorous, but the Malayan and Indian species are almost always fruit eaters, and I believe all of them prefer that kind of food when it can be obtained. They are seldom to be seen in cultivated districts, inhabiting almost exclusively the primeval forests, where the smaller species are often to be met with in flocks of a dozen or twenty, while the larger ones generally go in pairs. They fly very high, far above the tops of the loftiest trees, with neck stretched out and head bent downwards, progressing rapidly with powerful strokes of the wings, and accompanied by a sound which can be heard at a great distance. The noise produced during flight is in fact so loud and peculiar, that many persons cannot believe it to be produced merely by the mechanical action of the wings on the air. It may sometimes be heard a mile off, and as one of the larger species rushes by overhead it forcibly recalls the old legends of griffins and dragons, the awful sound of whose wings struck terror and dismay into the inhabitants of the country

they came to devastate. The sound which it seems to me most nearly to resemble is, the puffing of a locomotive when starting with a heavy train. There is only one other bird that I have heard produce a sound with its wings at all resembling (though not quite equalling) that of the great hornbills. It is the Muscovy duck (*Cairina moschata*) in its native country, South America. Both these birds have a very heavy body; both have, comparatively speaking, a small area of wing, and must, therefore, to support themselves, beat the air with immense force.

The rhinoceros hornbill sometimes exceeds four feet in length, and exhibits the greatest size reached in the Passerine order of birds. The exertion of flying is so great that it generally rests at intervals of about a mile on some very lofty tree, whence after a few minutes it resumes its flight. In some of the interior villages of Sumatra and Borneo, where a gun is never heard, they will settle upon and even build in trees in the village itself; but in more populous districts, where guns and Europeans abound, they are very shy, and take flight on seeing a man even at a considerable distance.

It is interesting to watch their motions when settled upon a fruit tree. Their weight is so great that they cannot venture out on the smaller branches, nor can they cling to the twigs, or flutter among the foliage like smaller fruit-eating birds. They cannot even hop readily from branch to branch, their short legs only serving to support the massive body. On first alighting they look cautiously round till they discover some spray of fruit hanging within reach of the branch they are upon, when they move sideways towards it by a sort of shuffling hop; and then stretching out their long neck, seize a fruit by the extreme point of the bill. To swallow it now they have got it, is however, no such easy matter; for the tongue not being adapted for deglutition they are obliged to jerk down every mouthful by suddenly throwing back the head, and at the same time opening the bill, by which action the fruit is of course thrown down the throat. This habit has given rise to the statement that this bird as well as the toucan throws its food up in the air before eating it; but a careful observation of the birds feeding in a state of nature, proves that the fruit never leaves the point of the bill except to be jerked down the throat. The action, however, so much resembles that of catching something in the mouth, that the mistake is easily accounted for. Having finished all the fruit within reach of one branch the bird with much deliberation takes flight to the opposite side of the tree, where the same operation is repeated till all the fruit that can be easily reached is exhausted. This is of course soon done, and it therefore happens that hornbills seldom visit a fruit tree more than two or three days consecutively; whereas pigeons,

barbets, bulbuhls, and other fruit-eating birds may be found on the same tree daily for as many weeks. The discovery of a dinner every day in the year must doubtless be sometimes a matter of difficulty to the larger hornbills, and they are often obliged to resort to other kinds of food. From the gullet of the *Buceros cassidix* I have taken the fragments of large long-horned beetles (*Batocera*), and when residing in the forests of Celebes I once had an opportunity of observing from the door of my hut one of these insects captured, beaten repeatedly against the branch, and then swallowed. On another occasion I shot a Moluccan hornbill (*Buceros ruficollis*), to the roof of whose beak was sticking a large lump of bees' comb, showing that he had been making a meal off bees' brood and honey. They are also positively declared by the natives to eat eggs and young birds occasionally. Yet notwithstanding this varied bill of fare there seems little doubt but that periodical scarcity of food is the most efficient check to their increase, as shown by the fact that the larger kinds are always scarce even where the smaller ones abound.

Most of the hornbills make their nests in hollow trees, though some of the African species are said to build rude exposed nests on lofty branches. The larger kinds lay only two eggs, the smaller ones probably a larger number, but all of a white colour. A remarkable habit has been recorded of at least three species, which, like so many of the strange facts in nature, was for a long time considered to be fable. As soon as the female has deposited her eggs the male imprisons her in the tree by closing up the entrance with clay and gummy substances, leaving only a small hole, out of which she puts the tip of her bill to receive the fruits with which he keeps her well supplied. She is kept shut up in this manner, some say, till the young are hatched, others till they are fledged. In the interior of Sumatra in January, 1862, one of my hunters brought me a male concave hornbill (*Buceros bicornis*), which he told me he had shot when in the act of feeding its mate. On going with him to the spot I saw a hole in the trunk of a large tree about twenty feet from the ground, out of which the bill of a hornbill was partially protruding. With great difficulty I persuaded some natives to climb up the tree and bring me the bird, which they did alive; and along with it a young one, apparently not many days old, and a most remarkable object. It was about the size of a half-grown duckling, but so flabby and semi-transparent as to resemble a bladder of jelly, furnished with head, legs, and rudimentary wings, but with not a sign of a feather, except a few lines of points indicating where they would come. A smaller species, inhabiting India and Ceylon (*Buceros monoceros*), is said by Mr. Layard to have a

similar habit. A third species found in Java (*Buceros plicatus*), very similar to the *Buceros ruficollis* of our plate, is said by Dr. Horsfield to be called by the natives "the jealous bird," from its extreme watchfulness over its partner. They assert that if any traces appear of the nest having been visited during the absence of the male bird he will on his return completely close up the opening with mud, and leave his unhappy wife and children to perish.

The voice of these birds is very harsh and grating. It is heard occasionally while they are flying, and also when they are alarmed. When, however, a bird is wounded or captured alive, the horrible noise it makes is perhaps not to be surpassed in the animal world. It is something between a bray and the shriek of a locomotive, and is kept up continuously, so as to be absolutely unbearable. When the female bird I have mentioned was captured on the nest we heard it about a mile off, a horrible noise even at that distance, and the screams continued without ceasing till it reached our boat. It is thought by some persons that the hollow protuberance of the bill may have something to do with the production of such a volume of sound, but besides that there is no communication whatever between the bill and the windpipe, the very large and strongly ringed trachea seems sufficient alone to produce it, especially when we consider the wonderful power and variety of the notes which proceed from the same organ in some of our small singing birds.

Classification.—The relations of the hornbills to other birds are rather obscure. Their large bills and general habits having much similarity to those of the toucans, they have been classed by some authors as the eastern form of that family. A careful comparison, however, shows that this resemblance is only superficial. The toucans have long and powerful legs, and can hop readily and actively about the trees on which they are feeding; but their wings are very small and weak, and their powers of flight are so feeble that in flying across the Amazon, which is three miles wide, they not unfrequently fall into the water from exhaustion. In the hornbills the reverse is the case, the legs being organs of support merely, and the wings the only means of motion. In the toucan's foot the toes are widely separated, the outer one being turned backwards, whereas in the hornbill the three anterior toes are closely joined together. The bill of toucans has no bony core and the tongue is excessively long, by both which characters it is widely removed from the hornbills. The internal structure shows this difference even more clearly, for the sternum or breast bone, which always has a general similarity of form in allied birds, is in this case as different as it well can be in two birds of the same order.

Other authors have placed them near the crows, on account of their conical bill and the semi-terrestrial habits of some of the African species, but almost every detail of structure is equally against this arrangement. The fact seems to be that they are a very peculiar and isolated group, with no immediate relations with any other birds. If we accept the general principle that all apparent isolations in nature are the result of the extinction of intermediate links which have once existed, we must suppose the hornbills, as we see them now, to be but a fragment of a great group of birds, containing many hundreds of genera and species, which once inhabited the great tropical continent, which there are indications of having occupied at a former geological epoch what is now the Indian ocean. Some of these birds would probably have filled up the gap that now exists between the hornbills and the other fissirostral birds, such as the kinghunters (*Dacelo*) of the east, and the puff birds (*Capitonidæ*) of America; for it is to some of these birds, though so much smaller and apparently so different, that the form of the feet, the structure of the skeleton, the shape of the bill in the embryo, and the character of the egg, show the hornbills to be really allied.

As in other families, which seem to be but the surviving remnant of much more extensive groups, there are among the hornbills some peculiar genera which differ much from all the rest. One is a rare Malayan species, the helmeted hornbill (*Buceroturus galeatus*), which, besides having two immense long streaming feathers in its tail, has a short straight pointed bill, with an immense hump on the top of it, which, instead of being hollow and light as in all the other species, is a solid bony mass of such density that the species has received a Malay name signifying "ivory bird." The habits of this rare and curious bird are unknown. The other anomalous form consists of the African genus *Bucorvus*, which has long legs, and habitually runs on the ground, where a true eastern hornbill never ventures. These birds are said to feed on insects, on small reptiles, and also on carrion, taking upon themselves something of the habits and outward appearance of vultures.

Geographical Distribution.—About forty-two species of hornbills are now known, of which eighteen or nineteen occur in Africa, nine or ten in tropical Asia, and seventeen or eighteen in the Malay Archipelago; a few of these being reckoned twice over as they occur on the borders of two of the districts, which however are, on the whole, inhabited by quite distinct species. In Africa they are found in all the country south of the Sahara, the smaller species being more abundant on the West Coast, while the larger semi-terrestrial species inhabit the more arid eastern districts. One or two of the smaller Asiatic species are

found in the mountainous forest country of Nepal, another seems confined to Ceylon; of the others some are confined to the Peninsula, others to Eastern India. How far they extend eastwards into Burmah or China is not at present known; but it is probable they will be found as far as the great forests extend in that direction, and from those regions it seems most probable we may yet receive some additional new species.

In the Malayan Archipelago the species are more numerous in the great islands of Java, Sumatra, and Borneo, in which twelve different sorts occur, ten of which are found in Sumatra, a smaller number in Borneo, and only three or four in Java. one of which is peculiar to it. In the islands farther eastward the species have a more restricted range, two very distinct kinds inhabiting Celebes, and being found nowhere else (the head of one of these, *Buceros cassidix*, is figured in our plate). Three are peculiar to the Philippine Islands, and one (*Buceros ruficollis*), of which the head is also figured, is found in almost every island of the Moluccas, in New Guinea, and in New Ireland, where the eastern range of these birds appears to terminate. They are quite unknown in Australia, and in the Archipelago, the islands of Timor, Flores, Sumbawa, Lombock, and Bouru do not possess them.

These facts agree very well with the supposition before made, that the hornbills were once more numerous and varied, and inhabited a now submerged continent, whence during the slow progress of geographical changes they have spread themselves to the surrounding countries. There is a great deal of independent evidence to show that the islands of Sumatra, Java, and Borneo were at no very distant epoch united with each other and with the continent of Asia, and we therefore find many of the species ranging over all these islands as well as some portion of the adjacent continent; while the islands further eastward, which have remained isolated for a much longer period, contain species which are peculiar to them.

The geographical distribution of the hornbills seems therefore quite in accordance with the almost universal belief of modern naturalists, that the present position of every living thing upon the earth is the result of that long and complicated series of geological changes and organic modification which the globe has ever been and still is undergoing.

DARTMOOR AND THE DART.

BY PHILIP HENRY GOSSE, F.R.S.

Near the middle of July, having a little boy just recovering from hooping cough, for whom change of air was recommended, I determined to take him to Dartmoor. There was much in the historic associations of that seat of ancient civilization, that region where Britons mined and smelted tin and copper, and where Syrian and Sidonian merchants met, and chaffered, and displayed the precious things of Asia, ages before Rome was born—much in this, I say, that had a strange fascination for me; and, besides this, it was a peculiar tract of country, where I expected to meet with unwonted forms of life, interesting to both of us. Accordingly my boy took his butterfly-net and insect-boxes, and I a vasculum for ferns.

It was in cheery mood, then, that we set out from Marychurch on that brilliant July morning. The long trailing twigs of the wild clematis were spreading in profuse and elegant freedom over the hedges and rocky slopes of the Teignmouth road, and hanging nearly to the horse's feet; and the dark and glossy leaves of the beeches almost intermingled as the long pendulous and patulous branches met overhead, as we turned off towards Hele. The fetid iris, a plant so rare generally, so common here, showed its pale violet blossoms, in contrast with the crimson stars of the rose-campion; and all along the lower level of the banks shone clusters of the sweet germander speedwell, always charming in its bright azure hue, and here, most poetically, named by the peasantry, "angels' eyes." Groups of tall foxgloves rose from out of the rank herbage, and high up in the hedges there was a constant succession of dog-roses and honeysuckles, adorned with numbers of the elegantly-banded hedge snails, on the scout for their dewy breakfast, and looking like fantastically painted fruits clinging to the twigs.

Through Newton Abbot we roll, and remark with surprise how fast it is increasing on every side. On towards Ashburton, the scenery becoming richer and more varied. It is market-day at Newton, and numbers of farmers' daughters and wives—comely Devonian dames—are riding to market with cloth-covered panniers attached to their side-saddles—well filled, doubtless, with butter and eggs, poultry ware, or whatever mysteries besides Dame Dobbins is wont to carry on such occasions. The hedgerows are still gay with flowers; the abundant yellow vetchling, two species of St. John's wort, the toadflax, precursor of autumn, and hawkweeds, supply the

golden colours; the foxglove and the campions the crimsons; and the blues and purples are afforded by the profusely elegant racemes of the tufted vetch, resembling pendent clusters of grapes in miniature. We miss the polystichum, our most common hedge-fern, and instead of it the filix-mas spreads its great crowns along the road-margin, and the tall brake crowds up among the tree-trunks of yonder wood.

Peeps of the Moor, at least its south-west corner, break upon us at various turns of the road, blue and shadowy, like a huge rampart, ever becoming, as we advance, more and more palpable. At length we enter Ashburton, between lofty walls, grey, weather-worn, and lichened. Old, old walls are these; for the crevices of the courses are thickly studded with dense tufts of the familiar wall spleenwort fern*; so thickly, that viewed at a slight angle the whole surface of the upper wall seems covered with the feathery fringe. The plants have the appearance of great age; they are very luxuriant, but this is the result of their long growth, for when examined they have a very different character from the long and broad-leafed succulent crowns that adorn the hedges at Daccombe. These are narrow, thin, dry and wiry, and far more plumose, and of a golden-brown tint of green. The great snapdragon also throws out its crimson spikes from the walls.

Here, then, in this quiet old-fashioned place, one of the four ancient Stannary towns, and boasting the honour of having given birth to Gifford, the quondam editor of the *Quarterly*, we took up our head-quarters.

One of our earliest walks was to the romantic Dart at Holne Bridge. Leaving the town by the opposite end of the long street to that by which we had entered it, we found the walls again clad with the *trichomanes*, if possible even more luxuriant, and accompanied with other ferns, as the wall-rue, the common polypody, the ceterach, the maidenhair spleenwort, and the hart's tongue,—all, except the last two, particularly fine. Indeed, we cannot walk a mile without perceiving how pre-eminently this is a region of ferns.

It was a pleasant excursion, that early morning walk, with the brilliant sun drinking up the dewdrops, and the lark singing overhead, recalling Shakspeare's beautiful fancy:—

> "Hark! hark! the lark at heaven's gate sings,
> And Phœbus 'gins arise,
> His steeds to water at those springs
> On chaliced flowers that lies;
> And winking Marybuds begin
> To ope their golden eyes."

* *Asplenium trichomanes.*

As soon as we are well clear of the houses, as if the curtain of a stage had risen, we open in an instant a magnificent panorama. The country to the south and west stretches up in lovely slopes, mapped out in parti-coloured fields to the sky-bounded summits of the hills, divided by hedgerows and hedgerow elms, with cottages nestling in the bottom, whence the brawling of the little Yeo comes to the ear, as it hastens on to join the Dart. We trace the receding valley on towards Buckfast Leigh, and far beyond in the same direction Brent Beacon, a fine purple cone, towers above the general level. The voices of haymakers taking advantage of the promising day, and the sweet odour of the turned hay, tell what is going on behind these impervious hedges of hazel and beech. Before us the dim grey tableland of the moor, or at least the south-west tail of it, lies under the softening haze of the morning.

On the right the rugged rock shuts out the prospect, for the road has been scarped out of the living shale, but the ever growing shrubs and their gnarled roots, with creeping and trailing plants, conceal the rough stone with a graceful drapery. Half hid by a pendent curtain of ivy, we noticed a shallow cavity—I can scarcely call it a cavern—in which was growing a clump of navelwort,* of more than usual luxuriance even for these Devonshire lanes. The leaves, stalk, and flowers, were all most succulent, not a blossom faded. One of these flower stalks, out of a clustered group, I measured; it was half an inch in diameter, and exactly thirty inches in length from root to point.

A little further on, from the same rocky barrier, a spring gushes out breast high, and is received into a stone coffer, like the new drinking fountains of London streets, the water as clear and cool as a thirsty pedestrian could desire; nor was our relish of it diminished by the fact that we found in its clear recesses other revellers†—thorough teetotallers all.

Presently a rushing brook passes beneath the road, and, being collected into a wooden channel, crossed with great flags for gangways, hurries away to a clacking mill. It was pretty to mark the dense subaqueous forest of water-blinks, how its long tufts waved and quivered in the black rapid stream, beneath the shadow of the tall meadow-sweet, most delightfully fragrant, that profusely bordered the water. This, however, was a deviation through inadvertence; recovering the road by a cross lane, we found the columbine growing luxuriantly, said to be most elegant with its tall blue blossoms, but now out of flower; and the tutsan, the finest and rarest of our truly native

* *Cotyledon umbilicus.*

† *Gammarus fluviatilis, Ancylus fluviatilis, Limnæus pereger, Helix rufescens.*

St. John's worts. The beautiful spotted bastard-balm,* rarer still, was also here in full bloom, spangling the hedge with its large white flowers, blotched with purple on the lip. This is probably the identical spot in which it was found by Smith, who gives as its locality "a mile from Ashburton, on the road towards Plymouth."—(*Engl. Bot.*)

Now we are in the valley of the Dart; and those hills that slope upward on our left, so densely covered with dark timber, making a noble appearance, are the Hembury woods, on the other side of the river. A little farther, and the whispering sound of running water is heard, which momentarily increases in fulness. We know it is the Dart; but the bank of the road is high, and curbs the prospect. Here is a gap in the hedge; we look over into a dark glen, shadowed by tall trees, and crowded with foxglove; yonder is a bottom of deeper green-wood obscurity, whence the denser beech woods rise on the opposite hill. There is the seat of the sounding stream, but we see it not. A few yards more, and we climb over into the solemn grove: the whisper has become a roar, and there sweeps the lovely river. Just where we have struck it, a ridge of broken rock crosses its bed; above this, there is a glassy expanse, mirroring the trunks of the bordering trees and the black shadow; below, a broken foamy torrent: there is a short but pretty plunge over the dividing ridge, with a deafening noise, that combines the whisper with the roar. The views upward and downward are both beautiful; the latter specially, where the tall overspreading trees—*patulæ fagi*—shadow the whitening current in a long receding vista.

I was struck with the resemblance borne by the bank of the stream to the sea shore; the shale crops out, and this is worn by the rushing flood into smoothed, but irregularly angular, projections and hollows, exactly like tide-pools, while the sand lying here and there, washed into ripples, increases the *vraisemblance*. Nor was the illusion altogether dispelled by the vegetation; for the *Osmunda regalis*—the royal flowering-fern—which grows all along the very water's edge, presented a strange likeness to a sun-dried sea-weed, for the clumps growing on the points of the shale, and out of the sand, had formed great compact masses of black wiry roots, from which in many cases almost all the soil had been washed away, and which threw up only a few stunted and deformed fronds, in no adequate proportion to the size of the root-masses.

A tiny brook comes down the left bank, and pours its little cascade into the stream, and just here we find some fine tufts of the hard-fern,† growing out of the sand. It is a fern which

* *Melittis grandiflora.* † *Blechnum spicant.*

we do not know around Torquay, but we became subsequently familiar enough with its long pinnate fronds. The azure heads of the sheep's-bit scabious, an old acquaintance, were peeping everywhere.

Pursuing the high road a few rods farther, we arrived at Holne Bridge, a solid granite structure that spans the Dart, well clad with ancient ivy and ferns. From the roof of its main arch depend stalactites, nine inches or more in length, formed by the free lime of its cement, each one bearing evidence, in its terminal drop of clear lime water, surrounded by a thin and brittle coat, of present increase.

Here we loitered for hours, lounging under the cool shadow of the bridge, admiring the *Jungermanniæ* and mosses that so luxuriantly cushioned the beetling hollows of the rock;* or gazing alternately up and down the river, from above the bridge and from below—up, where the stream comes brawling and sparkling down, curving round from the heights of Buckland woods, a mass of white foam, broken by dark rocky boulders; below, dark and mirror-like between tall beech woods on either bank; or peering, with that strange fascination which impels one with an ever increasing power to plunge in, on the deep hollows, so black and yet so smooth—so treacherously and invitingly smooth—"like sin," as my little son said.

I did not estimate the height of the bridge, but from recollection I should think the arch about twenty feet above the water as I saw it. Yet I was assured that occasionally the river is so swollen that the flood completely fills the arch. It must be a grand sight to see such a body of water, far exceeding the limits of the rocky bed, and filling a wide expanse of the bordering valley. It would then be a large river, and worthy of the lovely scenery by which it is encompassed; and, pouring down with its characteristic impetuosity, an impetuosity justifying its name of "Dart,"—it must, I say, be a grand sight. The floods of this river are extraordinarily sudden. After heavy rains in its elevated sources, far up in Dartmoor, of which perhaps not a drop has fallen here, the swollen waters come bearing down, all without warning, in the form of a mighty wall, like the bore of the Ganges in the monsoon.

Like the Lea near London, the Dart has the reputation of being peculiarly fatal, not a year passing without one or more persons being engulphed by it. This belief is embodied in a provincial distich:—

> "River of Dart! River of Dart!
> Every year thou claimest a heart."

The swiftness of its course, and the great unevenness of its

* *Splachnum ampullaceum* was particularly large and fine here.

bottom, full of treacherous holes and pits, combine with these sudden floods to give it such a character. People speak of its shrill wailing rushing sound as "the river's *cry*;" and say that during the stillness of night they hear it a long way from its banks.

Some little distance above the bridge the shale forms a noble precipice, rising with a rough face almost perpendicularly from the water's edge. It is crowned with fine timber, which descends on either side to the river. A romantic story cleaves to this cliff. A too-confiding maiden, deeply wronged by her lover, leaped, Sappho-like, from the summit; and hence the sheer descent bears the name of the Lover's Leap.

We heard a good deal of Widdicombe—"Widdicombe in the cold country;" "Widdicombe in the Moor;" "Widdicombe in the Dartmoors;"—"you *must* see Widdicombe by all means." Our curiosity was excited, and we set out. We wished, too, to see Widdicombe Tower, that tall embattled structure noted for its architectural beauty, and not less for its having been the scene of a most fatal elemental war. A terrible thunderstorm burst into the church during afternoon service, Oct. 21, 1638, and besides crushing and defacing the material building, killed four persons, and more or less wounded sixty-two. One of these was slain with unusual circumstances of horror. "Another man," says the local record, "had his head cloven, his skull wrent into three pieces, and his brains thrown upon the ground whole; but the hair of his head, through the violence of the blow, stuck fast to a pillar near him, where it remained a woful spectacle a long time after." Tradition affirms that the sufferer was sacrilegiously playing at cards in his pew at the time, and that it was the Prince of Darkness himself who, riding on the thunderbolt, accomplished the vengeance.

Well, Widdicombe and its tower must be seen. So we set out in the hard grey morning, leaving Ashburton by another outlet, a street sufficiently sordid, where the little river Yeo purls alongside the causeway, and disappears from the eyes of passengers to wash the back doors of the old quaint houses, and where dingy women are ever going up and down steps with pitchers and kettles. We get beyond houses and bridge, and pass as usual between walls bristling with feathery ferns, evidently the invariable in the outskirts of this little town.

The ground now rises fast, leading us through a high banked road or lane (I scarcely know which), where the male fern is profuse and fine, and the brake is also large and succulent, and delicately green. Ferns appear to have their proper domains. Presently these disappear, and it is all the black spleenwort with enormous fronds, so elegant in their triangular outline, and dark glossy greenness; and by and by nothing

but the hard fern springing out of the loose stone walls. Oaks stretch their arms above the road, and make an almost continuous canopy, through which the twinkling sunbeams struggle and play with soft pellucid yellow green light; anon these give place to sombre firs, dull, stiff and skeleton-like—the plantations of Welster.

A conspicuous object all the way up has been the works and tall scaffolding of a mine on a hill to the right. We are told its name is Druids' Mine, and we at once think of the Phœnician times; but no! it is a thing of yesterday—a London speculation of some five years' starting.

We toil up past the mine, and getting behind and above it have a fine view of the valley to the east, and of the country toward Newton. A tall hedge of dwarf beech bounds the road on one side, and furze thickets on the other. Here my entomological son got his first prize, for we saw specimens of the beautiful little green hair-streak, which presently became sufficiently abundant, and continued the characteristic butterfly up to the moor.

The driver pulls up, and pointing to the left says, "This is Welster Beacon." We look and see nothing to tempt us to get out. "No; but just over the brow you'll see Buckland Beacon, about a quarter of a mile further on; and that is one of the old Tors, where you'll see a good sight." We dismount, clamber over a gate, and are on a wide rounded hill, covered with button-like clumps of mingled heath and furze; a broad grassy path leads us to a rough stone wall, and there the Tor stands revealed in its majesty, with its conical crown of grey stone.

We are soon on the summit, gazing with eager eyes on the almost boundless expanse which stretches away on every side. It is a noble prospect. Unfortunately there is a haze in the air, which diminishes, though it does not destroy, the distinctness of the several features. The eye is first attracted by the winding sparkling Dart, which seems to be beneath our feet, as we trace it coming in from the distant moor, and then encircling in its twining embrace the lovely Holne Chace, which, with its rich timber-woods and its curving drive, looks from this height just like a villa garden with its gravel walk. Thence the charming river is seen, white with foam (I unconsciously listened for its babblings), meandering away to the south, till the tall woods conceal it. There too was Buckland Mansion, dwindled to a toy-house, and the grey church tower rising from the embosoming trees a little behind it. Beyond and around were the map-like fields of many hues chequered out with hedges, and far on the south-west horizon the blue Brent Tor.

In the foreground to the south there is Answell or A's'ell Rock, a very remarkable Tor, crowning an eminence considerably inferior in elevation to that on which we stand. Viewed from hence, it takes the form of a colossal lion couchant, with a second granite mass, that looks like an armadillo, or, if you please, the great fossil tortoise of the Siwalik, marching up behind him. The buildings and tall shaft-works of Druids' Mine, a little to the left, stand out bold and prominent. All the east is dim, and obscurely empty; but on the north rises Hay Tor, a fine purple cone of lofty stature, and the wide grey moor stretching away to the westward, a dreary, tabular, unvarying mass. The sides and slopes around our feet were spotted with a few semi-wild sheep, which we fondly concluded made the well-flavoured Dartmoor mutton, that the reader doubtless wots of; but the driver subsequently undeceived us as to this point. The true breed is found only on the moor proper, which we have not yet come to.

We descend perilously, for the granite is angular and rugged, and the short wiry turf particularly slippery. Besides this there is little vegetation, save the tiny bedstraw, profuse in white bloom, crowding the rocky crevices, and the rosy white stars of the English stone-crop, and a twine or two of ivy mantling the grey stone, and abundant lichens completely covering the old weather-worn surfaces. A pretty little yellow cinque-foil studs the short turf with its flowers, and on the rounded hill there is the furze. This is singularly close and dense, forming rounded knobs, as even and shapely as the well-shorn shrubs in a Dutch garden; the wind doubtless having performed the shearing operation here.

The mass of granite has a very noble and impressive aspect, as we gaze up upon it from the point where it breaks out of the turf. It takes somewhat of the form of an immense table, rising to a low cone in the middle, or something like a huge loaf that has sunk in the baking. The vast block of primeval stone, naked and hoary, is imposing in its severe simplicity, as it stands out broad against the sky, with no object around on the bare hill to distract the attention; and it derives a great extrinsic interest from its associations with early, perhaps even prehistoric, times. This is Buckland *Beacon;* and I picture to myself the pile of combustibles which in seasons of danger or other expectation was wont to stand on that massive table, and the wild form of the appointed watcher, possibly the bearded Druid himself, rushing up the hill with his flaming brand, and hurriedly lighting the pile. Then I see the fire lick up the heap of crisp and sun-dried leaves, catch the faggots of furze, and, overpowering the cloud of blinding smoke, burst forth into a grand pyramid of flame, whose leaping and curling tongues

rustle the scorched air, and roar like a tempest, while the red glare falls on the lone waste around. Then in an instant the attendant, gazing wistfully into the darkness, sees the answering fire blaze out on the summit of Rippon Tor, and, presently it may be, another spark, just discernible, tells that a more distant beacon has caught the signal, and sent it on; and he knows that before he can descend the slope and reach his lone hut, the whole of the wide moor will be studded with points of flame, and all the dwellers in the wilderness will have received the communicated intelligence.

Perhaps the ordinary occasion on which these signal fires were lighted may have been the approach of the Tyrian galley coming to trade for tin. The estuary of the Tamar has been shown on almost irresistible evidence to be the ancient Iklis, the port whence the Phœnician tin trade was carried on. Thither the accumulations of "silver, iron, tin, and lead," which the mines of this rich metalliferous region were yielding to the labour of a not unskilled and uneducated population, were brought for sale and barter; and thence the purple and fine linen of Tyre, the elegant manufactures of the Sidonians, the gold and precious stones and spices of India, and perhaps even the silks of distant China, were distributed through Britain.*

The arrival of the periodical galley from Tyre would then be an event which would put in motion the entire mining country; and we may well imagine that a series of signals would be concerted, by which it should instantly be known. These lofty Tors were admirably calculated for such a telegraphic system. Yonder blue mass in the south—Brent Beacon—overlooks Plymouth Sound and its approaches, and the appearance of a sail on the distant seaward horizon would not fail to be noted in fine weather. "What would be done," do you ask, "if the galley made the coast in misty or hazy weather?" I suppose in such case a signal fire would be lighted on the heights around the Sound, as soon as it became clear.

The flame from Brent would be responded to by Buckland in this direction, and by Sheep Tor in the west; from the former the news would flash to Rippon or Hay Tor, and be known then over the whole eastern region; from the latter it would be caught by Tor Royal, and thence by Crockern Tor, that seat of the Druidical legislature, and by Great Mis Tor, whence it would dart to Fur Tor and Yeo Tor, and to Watern Tor, that overlooks that wild lonely lake whence the Devonian rivers take their rise, and to Cawsand Beacon, from whose towering top the flame would be visible at once from both the

* See Heeren's Hist. Res.; *passim.*

northern and the southern sea. The distinguishing title of "Beacon," which immeasurable tradition has connected with some of these eminences, in no wise differing from their sister Tors, indicates the use which they subserved.

Reluctantly we leave these imaginings and turn our backs upon the ancient pile, Willie first rooting out a crown of the hay-scented fern from the foot of the "clatter," as a mass of granite so situated is provincially termed, and bagging a tiny lamellicorn beetle, and one or two more of the hairstreaks, that were fluttering over the furze-clumps.

We ride on, to make up for time lost in dreaming dreams of three thousand years ago, between the old roadside walls, made of granite blocks, rounded now by the effects of frost, and wind, and rain, and completely encased in lichen coats of many hues. Here the broad buckler-fern becomes the predominant form, remarkable for the very peculiar aspect produced by the recurvation of the edges of its pinnules, as if the plant had been just blighted by some baneful application, while yet retaining its succulency and greenness. The hard-fern and the male-fern, however, still occur also; the former unusually fine and well-grown. Great agarics too, and agaric-shaped *boleti*, are conspicuously numerous all along the road in this region. We pass through a gate, and are told that we are on the Moor.

A wide, desolate, heathy waste it is, undivided by fences (at least where we are travelling), but intersected by the high road. It did not oppress me with its loneliness; for the sun was bright, and horses were grazing, and sheep bleating, and butterflies were fluttering, and large handsome dragon-flies were hawking to and fro on rustling wings over the rain-pools in the sand-pits.

So we jog along, opening and closing in turn one and another of these wild fantastic heights, whose outlines ever change as we pass, and admiring the playing lights and shadows over the dark purple surface of the moor, as the clouds borne by the breeze expose or conceal the sun. The brooks enliven the waste, pouring along in haste, and sparkling among the granite boulders of their beds. Several of these cross the high road, the feeders of the Webbern, itself a tributary of the Dart, affording clear cold draughts to our thirsty throats, but with a somewhat ominously brown tinge and moory taste.

At length we emerge on a wide and most lovely valley; farms and hamlets scattered about its slopes, each, surrounded by its half-concealing groves of dark trees, look like oases in the wilderness. Some distance up the vale, which bends away from sight between the hills, we see the lofty church tower of Widdicombe, a fine gray square pile, of what is called the Per-

pendicular style, with four pinnacles at the corners. It rears its head far above the village, which seems to nestle among the embosoming groves as if desirous to be unseen. It is the frontier of civilization; far beyond all is the wild and naked moor. Imagination rests awhile on those sweet slopes, mapped out into fields, and spotted with clumps of noble trees, most of them ancient sycamores; and then, gathering its garments tightly round, strides onward into the unknown waste that lies among those sweeping moory mountains.

We did not go down into the village, but having satiated our eyes and our fancies, more ignoble, but not less clamorous propensities put in their claims for attention. Sitting down beside one of the gurgling moor-streams, we spread our frugal provisions on the short turf, pic-nic fashion, and ate and drank with gusto. Then strolling down the rivulet a few paces, I found it dilated into a shaking bog, where footing from clump to clump of furze, and from tussock to tussock of grass, was both scarce and precarious. I had been told that a singular and highly interesting plant, the sun-dew, that has the power of capturing unfortunate flies which rest on its leaves, grows in these elevated bogs, together with some other scarce plants, as the asphodel, and the beautiful little bog pimpernel. I found, however, neither of these, but the bright-eyed, laughing forget-me not, whose appeal I chose to read as made on behalf of the charming Vale of Widdicombe in the Dartmoors; and this I do not think I *shall* very readily forget.

Just as we were setting out to return, we had a curious evidence of the lonely and habitually undisturbed character of the place in the conduct of a little bird. A skylark descending came down close to us, singing as it came; and lowering itself on wide-spread wings, slowly reached the turf within a yard or two of our feet, without the slightest manifestation of fear, or even consciousness of our presence. A more unwelcome creature, but by reputation highly characteristic of the moor, crossed our path in the form of a viper, which the driver speedily demolished with his whip. It was the red variety, very distinctly and elegantly marked. The common people here call these reptiles by the strange name of *cripples*—a most unaccountable appellation surely. Musing on its etymology, it occurred to me that possibly it may look back to the Roman dominion, and may be the Latin *coluber*, the letters *l* and *r* being anagrammatically interchanged.

Another excursion of much interest was one that led us by Sharpitor and Dartmeet, to Wistman's Wood.

After striking the Dart at Holne Bridge, we cross and proceed through Holne Chace, a picturesque wood, from which the timber has been weeded out. Between the road and the river

our attention was directed to the enormous stumps of trees that had been felled even with the ground. The driver—the usual authority for tourists—informed us that the proprietor a few years ago cut timber from this property to the value of £60,000, which he bestowed as a fortune upon his daughter. The magnificent mass we are looking at was the base of the "queen" tree; the "king," of still superior vastness, is on the opposite side of the river.

Another quaint little bridge crosses the winding Dart at a most charmingly wild spot, having passed which, we rapidly ascend, and approach Leigh Tor (pronounced Léftor), a remarkable ridge of granite, crowning an eminence, which runs for some distance from east to west. We alight to examine it. It consists of enormous blocks so thrown up as to present a sharp angular keel to the sky, of course irregular and broken, and much more vast than it looks from the road. There was something very noble in its rude magnificence, as we stood against it. The common polypody in profuse abundance was creeping about the sides and points, making thick carpet-like draperies of its many bright green pinnate leaves, while in the dark crevices and obscure holes, overhung by the leaning blocks of stone, the broad buckler-fern was fine, and wood-sorrel displayed its three-fold foliage.

The woods of the Chace, through which we are still winding, are very beautiful; they are chiefly oak, but there is a great deal of birch, sufficient to give quite a preponderating character, and the light mobile foliage of this tree, "the lady of the woods," contrasts well with the massiveness of its lordly companion. Ferns too are very abundant and luxuriant, especially the *blechnum*, which I never before saw so fine.

The travelling becomes increasingly steep; the prospect behind and on either side wider and grander; the country through which we are passing is more than usually picturesque —old fashioned farm-houses, a primitive inn, an antediluvian smithy, and people as unsophisticated as the region; little brilliant streams crossing the road at every turn; fence-walls of huge, unformed granite blocks;—these at length bring us slowly and toilingly upon the moor.

And now we are in the midst of the Tors. Here they are, on every side, Pelion upon Ossa, Ossa upon Olympus! Away on the left, or, as a seaman would say, broad upon the larboard bow, rises from deep valleys a vast mass, of great regularity in outline, terminating in a sharp cone of gray rock. Other hills are beyond and on each side, but there is a grandeur in this which arrests the attention. Presently the road turns, and we see that we shall have to skirt the very flank of the mountain. A passing peasant, of whom we inquire its name, tells that it is

Sharp Tor, or, as he pronounces it, Sharpitor. As we pass, we perceive that its broad side bears antique remains, and jump out to explore. Yes; here are indubitable relics of man's handiwork. We are standing in the midst of a circle, about fifteen yards in diameter, as I measured by pacing, composed of great primary rounded blocks of granite. Besides these, however, there are the débris of the elevation, in heaps of smaller stones which lie at the base of the primaries, making the walls in places two yards or more in thickness. The primary stones are placed in contact, not separated by interspaces, and therefore this was a dwelling-house, not a temple or sacred inclosure. There is an avenue of parallel stones leading from the circle away towards the south-east, that is, to the nearest point of the Dart.

The great size of this circle, as compared with the ordinary hut-circles, which rarely exceed nine yards in diameter, is remarkable. It is not sufficiently wide to inclose a village, nor to serve as a "pound" for cattle. It would rather seem to indicate the residence of a chief, but I did not notice any second circle within the inclosure.*

The bright, laughing sunshine and the dancing butterflies were not favourable to those solemn reveries which the same scene under the silent moonlight, or in a twilight storm, would have conjured up. Yet it was not without a feeling of awe that I reflected on the hoary ages that had passed away since a man of like passions with me brought home his loved bride to that now lonely dwelling, and "his young barbarians all at play" made the air ring with merriment as they ran around those gray wall-stones, or chased the identical forefathers of those very butterflies over the moor. "How long was that ago?" How long? Who knows? Perhaps when Jephthah was offering up his burnt-offering; perhaps when Caleb was carrying the cluster of Eshcol.

Yar Tor rises just opposite to Sharp Tor, on the right hand of our road. This eminence is crowned by a strong wall, forming a square inclosure, formed partly by nature and partly by art. On the north-east slope we saw "the remains of some hut-circles, and the ruins of a kist-vaen," which are there; but time pressed, tokens of a storm lurked in the horizon, and I specially deprecated our being disappointed of seeing Wistman's Wood. We were therefore constrained to hasten past these interesting antiquities without examination.

* I took for granted that I should find full details of this remarkable circle in Rowe's *Perambulations*, which I referred to as soon as I arrived at home, but to my surprise he does not notice any remains on this side of the hill. Had I anticipated this silence, I should have made a more minute examination; the notes I have recorded above were, however, jotted down in my note-book upon the spot, and may therefore be depended on.

From the skirts of Yar Tor, looking south, the view is suddenly opened by our having left Sharp Tor in the rear; and the rounded hills which form the valley of the Dart take majestic forms, and have an aspect of sullen grandeur, but the river itself is not here visible.

Soon, however, we see it before us; and descending abruptly we come to a small bridge, by which we cross the East Dart, just before its junction with the West Dart; the spot itself and the bridge bearing the name of Dartmeet. The view up the east branch is extremely fine: the stream being very swift, and full of rocks, the wild riotous turbulence, the dashing, flashing water half lost in foam, and the high-toned metallic cry, take strong hold of the imagination. Looking up the west branch, and down the united stream, the aspect has the same character.

Beside the road which rises from the bridge, the elegantly cut lady-fern suddenly becomes so abundant as to be characteristic, throwing out its arching fronds from the walls, mingled, however, with the everywhere profuse hard-fern and brake.

Far up on the naked moor a little black object appears, to which our attention is drawn. We might have imagined it a traveller's portmanteau dropped from a carriage, or a bit of india-rubber left by a sketcher, so minute it looks on the desolate mountain-side, with no other object near with which to compare it. We are told it is a school; a school endowed by two benevolent ladies. A school forsooth! we should almost as soon have expected a coffee-house or a jeweller's shop. Where do the children come from? we asked. At last we reach it, the road leading by the door. It is built of corrugated iron, like a temporary railway station, and, however we might have doubted the call for such a building, there are the urchins within. Through the open door we see them sitting at the desks, gazing furtively at us, doubtless envying us freedom, and a ride. The school rejoices in the euphonious appellation of Brimps.

Not far from this our civil and intelligent driver took fire at the occurrence of a wall, which he had not seen before, not having been so far from home for a twelvemonth or more. It is a noble wall, well-built of massive blocks of granite split out of these endless Tors, and put together without the least bit of cement; the solidity and weight of the pieces affording the requisite stability. Wide interstices between the blocks are left purposely, that the force of the wind may not act unbroken. What a shrill wail these varying orifices must utter in a high autumnal gale! The immense size of the blocks, contrasting with those of the ancient walls around, shows the resources of modern art; for this wall is built by Government. It was this

that stirred the wrath of our friend, who protested eloquently against the encroaching policy of the Duchy of Cornwall, robbing, as he averred, the poor moormen of their scanty pasture. At first we could not see the object of the inclosure, but presently a healthy plantation of young firs within the grim fence explained it.

All before us spreads the wide moor, ever wilder and wilder. Solitary farms smile at distant intervals in the bottoms. One of these, Sherbiton, prettily surrounded with trees, by a brook, specially attracted me. Abundant springs of water occur everywhere; the moor is evidently a Jamaica, a "land of springs." Far away in the west we see Princeton and the War Prison, which at one time held ten thousand prisoners. Grim and gaunt it stands on the naked mountain side, encircled by its gray granite walls. On the right of this uninviting object, but much more distant, a magnificent Tor rises against the sky, striking the eye by its noble outline and manifest elevation, pre-eminent above its fellows, and exciting curiosity to know its name. At length a peasant informs us that it is Great Mis Tor.

This is one of the loftiest peaks on the moor, and appears to have been a chief seat of the Druidical astrolatry; at least, if that etymology of its name be sound, which derives it from Misor, the British moon-goddess, answering to the Ashtoreth of the Sidonians. The out-croppings of the granite on the summit of the Tor are described as taking magnificently massive forms, and, on the top of the loftiest, at an elevation of 1760 feet above the sea-level, there is one of those singular circular pans which have provoked so much discussion as to their origin. From their situation, and the regularity of their form, it has by some antiquaries been maintained that they were connected with sacerdotal service, used either for the washing of the sacrifices, or the ceremonial lustrations of the priests, and that they were excavated by human skill and labour. Others believe that, beautifully regular as is their shape, they are merely the result of natural decomposition. If so, however, they are not the less likely to have been pressed into the service of the dominant idolatry. The one on Mis Tor, commonly known as Mis Tor Pan, is remarkably smooth, and perfect in its outline, about eight inches in depth, and a yard in diameter.

However, this was far beyond our present limits. We jog on by Hockaby Tor, a crowned eminence on our right of no great elevation, but interesting, because on its slope there are several hut-circles distinctly visible from the road, distant from it, indeed, only a few rods. We ford Oxlake Brook, a little feeder of the West Dart, which we see winding among the hills

at our left, running nearly parallel with the road, and forming brilliant little pools here and there under the midday sun. The slopes from Sherbiton are covered with boulders, which *may be* ruins, but which appear from their wild confusion and ruggedness to lie where they were protruded in some primeval convulsion of nature. Their number imparts an unusual aspect of savage desolation to the scene. Here on a granite block was sitting a yellow-ammer preening its bright plumage in the sun, and all unconscious of sadness. The local name for this familiar little bird is "gold-gladdie;" a pretty appellation, well suited to the appearance of a gay-coloured bird in a lonely and desolate region.

Our road now is bounded on one side by the wall of Dinnabridge Pound. Within the enclosure near the gate there is a lichened chair of granite, evidently of great antiquity, which tradition asserts to have been brought hither from Crockern Tor. The Pound itself is comparatively modern; it is a large inclosure, surrounded by one of the dry stone walls so universal here. It owes its origin to the customs of the moor. The entire forest is farmed out under the Duchy of Cornwall to certain persons termed moormen, who receive cattle for pasture, affixing to each animal "the moorman's mark." On one day in the season, of which he gives no notice, the moorman drives all the cattle on his quarter to a given spot, and impounds every one that has not his mark.

The sheep and cattle, though allowed to wander apparently without restraint, are said always to keep company with those of their own flock or herd. We could see this to be true with respect to the sheep: though we passed a great number in our course over the moor, we never saw those marked with one colour or set of letters mingling with those otherwise marked; they associated with their own exclusively. These are true "Dartmoor muttons," a little breed, which you would think to be lambs. The sun was powerful, and the poor things in this shadowless region were fain to creep up under the north side of the stones, and even at the sides of the shallow pits whence turf had been dug, as an apology for shade, though even when they lay down more than half of their bodies were in the full blaze.

Just beyond Dinnabridge Pound we see a fine Tor, which bears the name of Belevor, one of the numerous eminences in which the name of Bel or Baal is traced—a remnant of the Oriental idolatry which spread its baleful wings over this region in primitive ages. The country hereabout is full of aboriginal monuments, and the Tors rise thickly on the right and in front of us; the mountains bristle with rocky peaks and points, like monumental stones in a churchyard—grim memorials of the

long, long past. Conspicuous among them is Longaford Tor, with its sharp conical crown, and in the foreground Crockern Tor, once a place of renown.

On this bleak and desolate mountain, in the midst of these hoary stones, with only the sky for a canopy, be it clear or cloudy, bright sun or driving rain, soft zephyr or howling storm, met the ancient Stannary Parliament. Each of the four Stannary towns, Chagford, Ashburton, Plympton, and Tavistock, sent twenty-four burgesses to this assembly, when summoned by the Lord Warden of the Stannaries. They enacted laws, which, when ratified by the Lord Warden, were in full force in all matters between the tinners, "lyfe and lym excepted." Probability and tradition, however, assign a far higher sanctity to this spot, as the seat of Druid legislature. The Stannary Court was but a form, comparatively modern, of an assembly which had been wont to meet there from earliest times. Polwhele says that in his time there were the president's chair, seats for the jurors, a high corner-stone for the crier of the court, and a table—all rudely hewn out of the granite of the Tor, together with a cavern, which may have served as a dungeon for the condemned. A moorland patriarch who had known the spot for threescore years, told Mr. Rowe, in 1835, that he perfectly remembered the stone chair, which was ascended by four or five steps, and that overhead it was protected by a large thin slab of stone. There seems to be little doubt that this chair now stands in Dinnabridge Pound.

A strange feeling pervades the mind as one stands thus amid the memorials of a hoary and dim antiquity, and calls up the gathering assembly, with its stoled priest and its sucking lamb, and perhaps other sacrifices, from which imagination hides her face, dripping blood on these huge stones—perhaps at the very time that Samuel was judging Israel in the circle of Gilgal, and obtesting at the stone of Eben-ezer. The nakedness and utter desolation of the region still and solemnize the mind, notwithstanding the cheerful sun and the swift chequering clouds. In the shadows of evening it must be an awful place, when fancy would people it with the shadowy ghosts of four thousand years, and every stone would take form and life.

Again we descend to the river at a place called Two Bridges. There is, indeed, but *one* bridge that I could see or hear of, and the only way I can account for the name is by supposing that there existed, coevally with this modern structure, one of those very ancient ones, usually described as "Cyclopean," made by upright monoliths for piers, and enormous slabs of granite made to rest on these horizontally, the stability of the whole depending on the immense weight of the blocks. Several of these interesting bridges yet remain to attest the

solidity of their construction, particularly one over the East Dart, near Post Bridge.

Close to the river, at Two Bridges, a country inn of more than usual pretensions, surrounded by its offices, gives animation to the scene. The sign, once doubtless a fine example of high art, representing a robed and bearded personage, life size, now, from the painting having never been varnished, and the colours having fled, presents an appearance ludicrously ghastly. An antique ostler, curiously in keeping with the associations of the place, appearing, we inquired our way to the wood, the object of our search, while the driver dived into the recesses of the bar, to get "summat." The man of horses, with a ready civility, and a free use of "yir 'annor," which suggested a Milesian education, pointed up the valley of the Dart to the slope full in sight, at what appeared to be only a few hundred yards distant, where a very circumscribed thicket of scrubby furze (so it looked) was growing. "An' that," said he, "is Wistman's Wood; an' it's a mile and a half's walkin'."

My little son and I tramped away up the valley, the scrub still in sight every step of the way, which ever grew wilder and wilder. Through a dreary farm-yard we post, and the world is behind us. Our course is parallel to the Dart, which purls and rustles below, under the shadow, for some half mile or so from the bridge, of magnificent dark beeches. The utter absence of recognizable objects makes distances strangely deceptive. Still wilder and wilder grows the moor; here and there we suddenly find our feet press a shaking bog. No sign of animal life, but a pretty little butterfly,* which is numerous. Yes; in that little pool in the rocky stream, a trout leaps into the air; another, and another; though the dimensions of the pool are such as you might stride across, and its depth seemingly fathomable with your hand.

The furze begins to take form, and to look like dwarf trees, and far above frowns the blue peak of Row Tor, around which dark clouds are gathering. Now the granite blocks become thicker and more numerous, till we find ourselves crossing a wilderness of boulders, where we can proceed only by scrambling from one to another, there being literally no way between, the narrow interstices being choked with brake and moss, and the stone-crop. I never before saw a place which gave me such an idea of utter desolation. At length we reach a single solitary oak, the outpost of the wood, and after a little more difficult and dangerous scrambling over the blocks, we enter the weird forest itself.

I despair of conveying an idea of the strange scene by

* *Hipparchia pamphilus;* a variety much paler than the ordinary condition.

words. The granite boulders continue as close as before, with the stunted and moss-gnarled trees springing out of the interstices. It is said that these narrow passages go down, down, to an unknown depth, and some have thought that we see only the summits of the trees, the trunks, of ordinary height, being rooted in the earth far below. I did not think of probing the treacherous crevices, which are reputed to swarm with adders; but there is that in the aspect of the trees which at once confutes this hypothesis; not to speak of the absurdity of supposing that the granite boulders have gradually accumulated since the existence of the trees.

That these oaks and rowans are enormously old I do not doubt. Those which I saw might have trunks a foot in diameter on the average, and their height is from twelve to fifteen feet. The branches are wonderfully twisted and knotted; the heads are scanty, flattened, and wide-spread; and both trunks and boughs are so thickly encrusted with dense moss, that ferns grow profusely upon them.* The foliage is not unhealthy; and I observed numbers of those globular galls, like a boy's marbles, which have lately attracted notice in South Devon. I saw no young trees, no suckers, no acorns. Individual immortality seemed to be conferred on these remnants of bygone times, but nothing that indicated transmission of life to another generation.

I should much like to see a section of one of these old trunks; to count the concentric circles, and thus obtain a clue to their actual age. At the Norman Conquest the wood is said to have presented the same appearance as it now does; and I should think it by no means an unreasonable conjecture that these identical trees have witnessed Druidical rites. The explanation of the name, "Wistman's Wood," as *wiseman's* wood, has been ridiculed; but, considering the ancient form of "*wist*," (from the Saxon ꝑíꝛtaŋ,) *to know*, it is highly suggestive: *q. d.*, the Wood, or Sacred Grove, where the *Knowing-man* performed his incantations.

By this time the heavens were gathering blackness, and from several points of the horizon those dark, ragged clouds were rising and hanging in tattered shreds, that tell of heavy rain. Mutterings of thunder, too, were audible; and notwithstanding that a thunder-storm in such a place as Wistman's Wood would have greatly augmented its melodramatic interest, yet neither on my own nor my sick child's account did I exactly wish to brave its results. We, therefore, hastened back to Two Bridges, casting many a wistful glance on the strange scene we had left, the like of which we might probably never

* *Polypodium vulgare*, and *Lastræa dilatata* and *recurva* profusely.

see again. It took a peculiar aspect under the glowering sky; and the distant peak of Row Tor above, lighted up by a momentary gleam of sunshine, came out wonderfully fine against the black storm-cloud.

Some points of interest occurred on the homeward route. Several hut-circles were seen close by the road-side at Haxary, where the West Dart gleamed beautifully in a romantic dell. Then we reached Compstone Tor, crowned with a fine assemblage of granite rocks of that peculiar form known as the Cheesewring; enormous slab-like masses of varying diameters, piled one on another horizontally: I say "piled," for such is the appearance; though doubtless the phenomenon is the result of elemental decomposition on the horizontally stratified granite. This arrangement has a very magnificent effect.

Benjay Tor, a lofty hill, which presents a precipitous face of broken stone to the bed of the turbulent Dart, was a striking object, the river forming two deep and dark pools beneath, which are called Hell Pool and Bell Pool. But, I think, as interesting as anything that I had seen, not excepting even the architectural remains and the old wood, were the traces of the ancient Tin-works. From Compstone onward to Holne, an elevated, heathy region, there occurred, at brief intervals, large tracts of ground which had been excavated to a shallow extent, and which have a very peculiar and easily recognizable appearance. They are of course covered with common vegetation, but the removal of the surface earth producing a depression of the level has an effect so unique, that the beholder, after he has had one or two of these "golfs," as they are termed, pointed out to him, readily detects one as he approaches it, and at once discriminates between these and any other irregularities in the country. These "golfs" are the spots where, in remote ages, the people searched for tin; the metal was found very near the surface, and was separated from the soil by the action of running water. A running stream (and this region abounds with such) was chosen, and so enclosed and directed as that its force should fall upon the metalliferous soil, when the lighter earth was washed away, and the heavier ore remained. This process was called *streaming;* and it is believed that the ancient tinners were acquainted with no other mode of obtaining the metal.

Near Ringershots, the driver pointed out to us an ancient tin-stream, and it was with curious interest that I examined it. It is a romantic little gully, or glen, close by the road-side, all overhung and concealed by mountain-ashes, where a tiny thread of water now trickles with a metallic tinkle down the black, boggy soil. It has probably been unused for ages, but tradition has preserved the record of its former use, though

the water which once made it available has long been drawn into other channels.

Thoughts of the old Phœnician rovers came up before my mind as the shadows of evening gradually shut out the scenery; and in imagination I followed the white metal—scarcely less precious than silver—across the stormy Bay of Biscay, through the Pillars of Hercules, and up the Mediterranean, till I saw it spread out in the market of Tyre; and, amidst the concourse of traffickers, heard the voices of the eager merchant-princes, crying, as they strode in front of their stalls, "Bedil from Tarshish! Bedil! Pure Bedil! Bright Bedil! Buy, buy, buy!" And then there came a twinkling of blue, and purple, and fine linen; and a chaffering and charming of many voices; and a Babel-hum of confused sounds. But the familiar voice of the driver said, "Here we are at Holne Bridge;" and the vision vanished. Yet I was glad that such was the last impression I had of Dartmoor.

SPECTRUM ANALYSIS APPLIED TO THE STARS;

OR,

THE STARS, WHAT ARE THEY?

BY WILLIAM HUGGINS, F.R.A.S.

"Ye are a beauty and a mystery," sang the poet as he saw the stars mirrored in the crystal face of Geneva's lake. A beauty theirs, which time affects not, and which glows with undiminished lustre upon successive generations of men. But the coils of the mystery are loosening. One coil was unwound, when more delicate methods of observation showed that twin stars, in their close companionship, move about each other in accordance with the same laws of gravity by which our solar system is knit together and upheld. Another coil is now loosening, as by the continual watching of numerous observers, are being traced out the periodic curves of increase and diminution in brilliancy of those stars whose light is variable. Yet they remained a mystery still as to their substance. What are the stars? Matter, certainly, and matter analogous to that of which the sun and planets are built up, since it exhibits similar laws of attraction. But is this matter composed of terrestrial elements? Could our chemical notation be adopted by physicists in Capella, and Arcturus, and Sirius? This seemed a tightly-bound coil of mystery which human fingers could

scarcely hope to unwind. As long as the methods of chemical analysis required the substance to be within the grasp of the experimentalist, the attempt was hopeless. We could never expect to weigh fragments of Sirius, or measure in the laboratory the chemical influences of the Pleiades. Recently, Kirchhoff and Bunsen, skilfully combining the researches of numerous previous observers, have placed in our hands a method of delicately analysing many substances *at a distance*. Fortunately, the stars belong to the class of bodies to which *analysis at a distance* can be successfully applied. Light is the go-between, the bearer of a message which can be read as surely at 1000 millions of millions of miles as at ten inches. Light contains in hieroglyphic characters the names of the substances which exist in the source of light, and we are indebted chiefly to Kirchhoff for the key by which this writing can be deciphered and read.

Newton admitted a sunbeam through a small hole into a dark room, and caused it to be bent out of its course by placing in its path a prism of glass. He was richly rewarded by the separation from each other of the different coloured lights which, by their united influence, affect us as white light. Each of these being bent from its course according to the velocity of its vibrations, the sunbeam is spread out, the rays that have travelled together to us from the sun diverge from each other, from the red, which is least diverted, to dark purple, which is the most bent aside. Conceive of a fan, the sticks of which are coloured red, orange, yellow, green, blue, indigo, purple. Closed, it represents a sunbeam. Opened, the same sunbeam spread out by refraction through a prism. If in place of a round hole the light be admitted through a very narrow slit, so as to diminish the glare by the removal of the overlapping light, and certain other precautions be taken, it will be seen that the coloured rays of the solar fan are closely written over with dark lines. The whole of the spread-out sunbeam is full of dark lines, differing in thickness, and in shade of blackness, and arranged in definite groups. Wollaston first saw them. Fraunhofer, in 1815, published a map of the solar spectrum with six hundred of these lines laid down. To the principal ones he gave the names of the letters of the alphabet, though he dreamt not of what those letters would spell if rightly combined and interpreted. (See Fig. 1.)

Since that time, many observers have examined other lights than that of the sun, and it has been found when the light from metallic flames is similarly spread out by refraction through prisms, that the spectra resemble broken fans, certain of the coloured sticks being absent in some, certain others in others. Thus the light of sodium has only the yellow stick, and that is

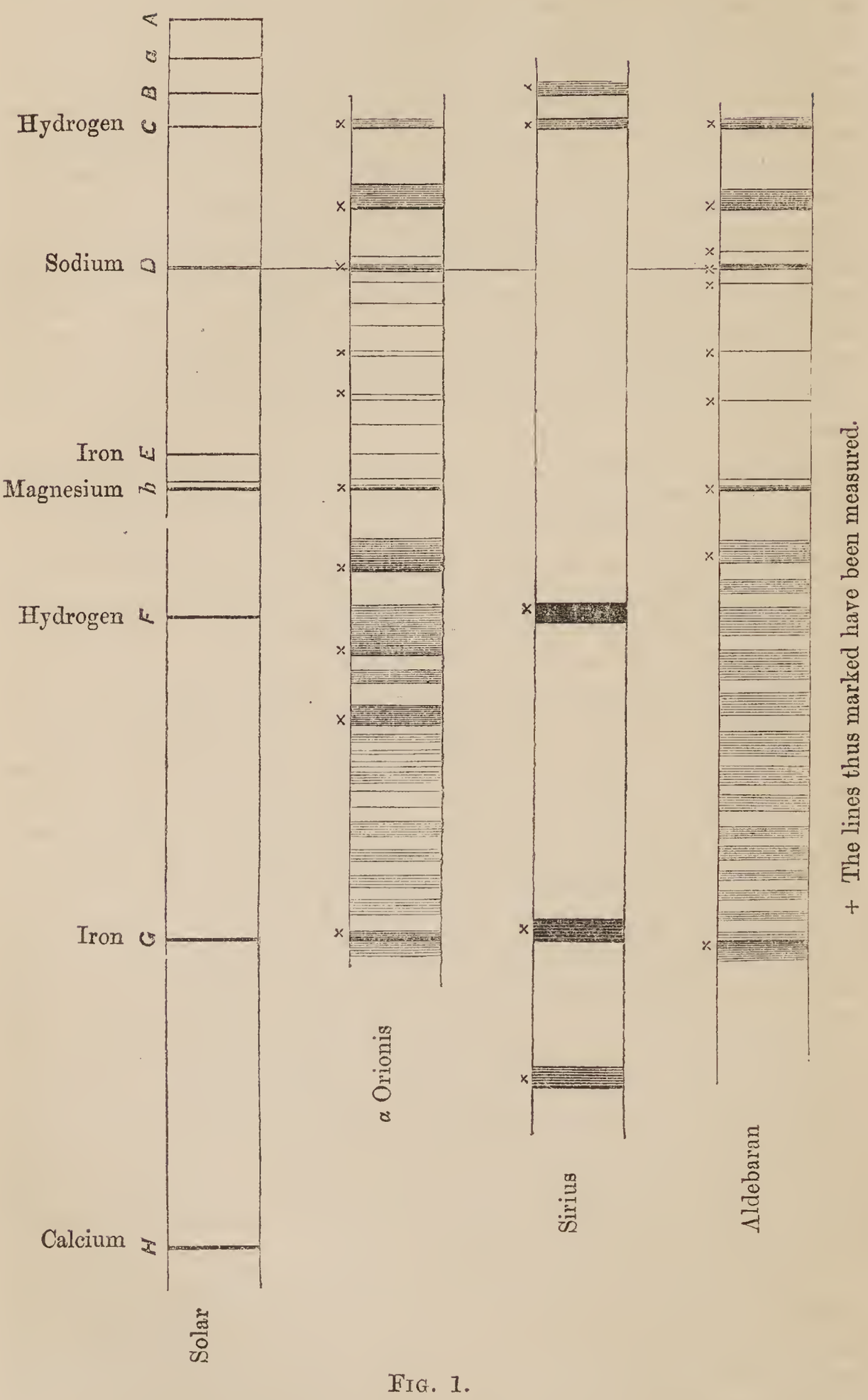

A
a
B
C
Hydrogen
D
Sodium
E
Iron
b
Magnesium
F
Hydrogen
G
Iron
H
Calcium
Solar
α Orionis
Sirius
Aldebaran
+ The lines thus marked have been measured.

FIG. 1.

split in two. Each metallic flame has its own characteristic spectrum. The light is not a continuous shading into and mixing with each other of the prismatic colours from the red to the purple, as is the sun's light, but consists of sharply limited bars of light with dark gaps between. Each metal is thus individualized by the grouping in position of these coloured bands, by their relative intensity, and by their place in the spectrum. The appearance of each metallic flame, when thus examined, is as peculiarly distinctive as each man's countenance is unlike his fellow's, and fixes his identity. As increased light brings out upon a friend's face more minute individual traits, without changing those which are broadly marked and seen at first sight, so, in the case of most metals, increased heat adds to the number of the bright lines, but does not alter the grouping, or change the position of any of the lines of light emitted at a lower temperature. Thus the new metal thallium, the whole of whose light at a low temperature is concentrated into one intense green line, emits feebler lights of different refrangibilities as the heat increases, and when the electric spark is taken between points of thallium, eight other lines may be counted, in addition to the characteristic band of bright green.

So delicate a mode of analysis is thus afforded us, that a quantity of a solution of common salt which does not contain more than $\frac{1}{2,500,000}$ of a grain of sodium, will exhibit the well-known yellow band of sodium. More valuable than its delicacy, is the facility with which this mode of analysis distinguishes bodies in minute quantities which comport themselves similarly in respect to ordinary re-agents. In a ton of the water of the spring at Durkheim, besides chloride of potassium, are minute traces of two other chlorides, which would have remained undistinguished by ordinary analysis. Bunsen and Kirchhoff discovered them by their characteristic lines of light when placed in a flame. Two lines of celestial blue, and two dark red lines, revealed the presence of two hitherto unknown metals, cæsium and rubidium. The latter is a metal with which we have daily to do, since it exists in tobacco, in tea, in coffee, and in grapes. More recently, Mr. Crookes in this country, and on the Continent M. Lamy, by the same method, have independently added to our metals, thallium. This method of analysis not only detects traces of matter infinitesimally minute, but permits *unlimited distance to separate the experimentalist from the substance he would examine.* Hence it is not bounded by terrestrial limits, but can be brought to bear upon the sun, and the immensely more distant stars.

THE SUN.

It is to Kirchhoff that we are indebted for being able to take the bright lines of the metallic flames, and apply them as a key

to unlock the mystery of the dark lines of the solar spectrum. The dark lines are the shadows of the bright lines, or, more accurately, they are spaces of darkness where the bright lines would have been had they not been intercepted. Between us and the sun what is there to arrest the light? What arrangement of screens can exist which shall stop out these fine lines, and these lines only? The Heidelberg professor shows that the vapour of each metal is a perfectly opaque screen to light of the particular refrangibilities of its own bars of light, and yet perfectly transparent to light of every other refrangibility. Place common salt in the flame of a candle, in the spectroscope the double sodium line is sharp and distinct in the long continuous spectrum of the hydrocarbon flame. Now, cause sodium vapour to rise between the flame and the slit, the invisible vapour will intercept the sodium light as perfectly as a plate of iron, at the same time that it is clearer than glass to the light of the vapour of burning tallow. A fine double line of darkness will now be seen in the place occupied by the bright sodium bands.

Again, take a flame giving a continuous spectrum, such as that of a paraffine lamp, or the light emitted from an incandescent solid body, as lime in the oxyhydrogen flame, and, as before, cause sodium vapour to rise between the source of light and the slit of the apparatus; a finely double line of darkness will be seen exactly in the place which the sodium line would have occupied, had there been sodium present in the source of light. Such are the dark lines of the spread-out sunbeam; spaces of darkness, more or less intense, caused by the absorption of the light by metallic vapours, each vapour absorbing or intercepting its own group of lines. To decipher the dark lines of the solar spectrum, it is only necessary to compare the dark lines with the bright lines of burning elements, noting the coincidence of line with line, until, by the actual agreement in relative position of the whole group of lines, the name of the metal whose vapour is between us and the sun can be spelt out with certainty.

In Fig. 1 is a diagram of the solar spectrum, with the principal lines, from A in the dark red, to H in the purple, which is nearly the limit of the visible spectrum.

Fig. 2 shows a few of the lines contained in a small part of the spectrum, that bounded by E and *b*. These lines we have called hieroglyphic letters, and their power is due *to their position in the spectrum*, as if the letters of this page were similar in shape, and distinguishable alone by their distance from the margin of the paper. Hence the necessity for accurate measurement in position of the lines, and so minute must be this accuracy, that probably no certain results in deciphering

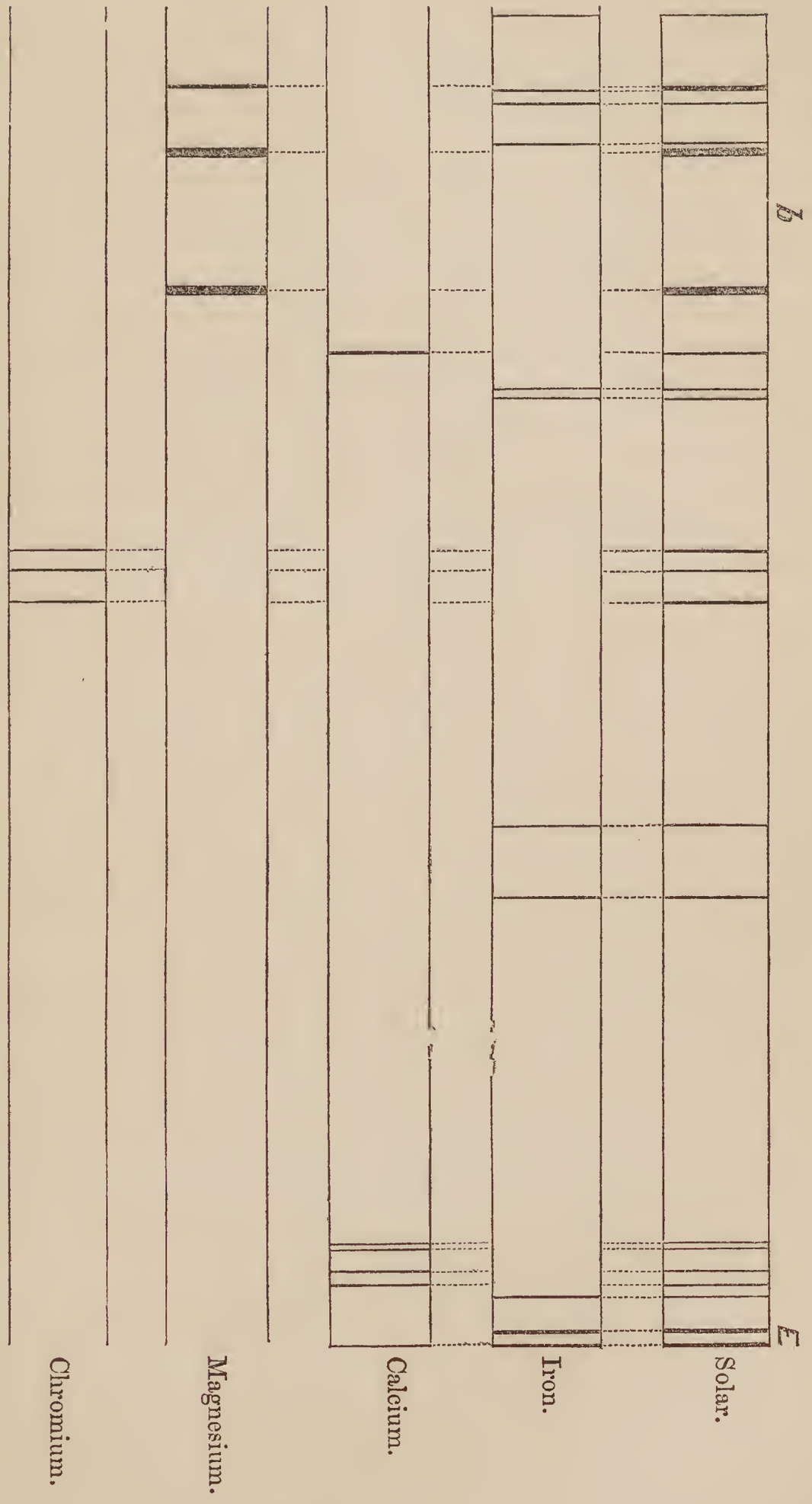


Fig. 2.

the solar lines would have been obtained, if apparatus had not been designed by which the solar spectrum and the spectra of the metals could be seen side by side, as in the diagram, and the actual coincidence in position of solar lines with the bright metallic lines directly observed. As the solar spectrum is crowded with thousands of lines between A and H, the coincidence in position of a single dark line with one bright line would possess, at most, but a light weight of probability. The attention of the reader is asked to Fig. 2, in which are seen the more remarkable groups characterizing four metals, and the absolute coincidence of these groups with groups in the solar spectrum. If the relative position and intensity of the lines of each group, as well as their place in the spectrum, be closely considered, it will be seen that what would be but probability in the case of a single line, advances to become proof in the case of a complex group. The strongest case is that to which Kirchhoff refers—the iron group of lines. A small part only of this is seen in the diagram. Kirchhoff writes :—

"In the portion of the spectrum, in plates 1 and 2 (from D to a little beyond F), about sixty iron lines appeared to me to coincide with as many dark solar lines; the probability that this coincidence is a mere work of chance is therefore considerably less than $(\frac{1}{2})^{60}$, and therefore less than $\frac{1}{1,000,000,000,000,000,000}$. This probability is rendered still smaller by the fact that the brighter a given iron line is seen to be, the darker, as a rule, does the corresponding solar line appear." It might as soon be supposed that this page has been produced by the fortuitous concourse of type, as that the coincidence of these large groups is accidental, and they are not causally connected.

But are these screens of metallic vapours *in the sun?* If not, where are they? The only alternative is to place them in our atmosphere, which is manifestly untenable. We know of no terrestrial causes to produce them, nor are there any laws by which we could conceive them to continue to exist as vapour in our atmosphere, even if produced. Experiment is against it. The lines, when viewed through a longer column of air, when the sun is rising or setting, are not more intense, but, as a whole, are less so. Under such circumstances, other lines come into view which are usually attributed to the atmosphere, but with these we have not now to do. Mr. Glaisher, referring to his balloon ascent of April 18, says: "At four miles above the earth the number of lines in the solar spectrum appears to be increased, and, therefore, none of the lines as viewed from the earth would seem to be atmospheric." The other alternative, that these vapours exist in the solar atmosphere, is what we should expect from the high temperature of the sun. Cosmically connected as are the sun and the planets, it was to be

expected that terrestrial elements would have a place in the sun. At present thirteen or fourteen have been read in the solar lines.

In Fig. 1, the reader will find the names of the metals against the principal solar lines, which these represent, according to the researches of Kirchhoff and Angström, with the exception of the line B, which Angström attributes to potassium. The writer's own observations show that the dark red band of potassium is closely approximate in position with A, but is not coincident with it, being in a small degree less refrangible. Kirchhoff leaves F undetermined. Angström and Plücker agree that F is coincident with the greenish blue band of rarefied hydrogen. Besides these the following metals are in the sun: nickel, cobalt, chromium, manganese, aluminum, and probably strontium and barium.

The most probable supposition from these facts is that, "the sun consists of a solid or liquid nucleus heated to a temperature of the brightest whiteness," and surrounded with an atmosphere of a somewhat lower temperature, in which are commingled vapours of all substances volatile at the solar temperature.

THE STARS.

If the constitution of the sun can be deciphered at ninety-five millions of miles, why not the stars at a million times that distance. The length of time the light is on its way will not affect the message it bears. It is written in language that never alters, recorded in characters that never become obsolete. The investigation, however, is hedged round with other and formidable difficulties. The light from the stars is comparatively faint, and yet if the lines are to be satisfactorily distinguished, this light must be spread out to a considerable extent. The slow, measured march of the heavenly host from east to west may be counteracted by clockwork attached to the telescope, but not so the continually moving currents, and ever changing want of homogeneity of our atmosphere. The last difficulty reduces to but a small number during the year the nights on which the finer lines can be seen and mapped.

The writer of this article, in association with Professor W. A. Miller, entered upon this very delicate inquiry in January, 1862. A few broad bars in the brighter stars were soon seen, but considerable time has been consumed in perfecting an apparatus, by which *the true stellar spectra*, which, like that of the sun, consist of *numerous fine lines*, could be well observed and accurately measured. The investigation is being carried on in the observatory of the writer, at Upper Tulse Hill, near London. The specially constructed spectrum apparatus is attached to the eye-end of his telescope. This is a refractor

of ten feet focal length and eight inches aperture. The object-glass is a very fine one, and does credit to the skill of Alvan Clark, of America. The equatorial mounting is the work of Cook and Sons, of York. The special spectrum apparatus is so constructed as to concentrate the whole of the light gathered by the eight-inch object-glass into a short and fine line of light. This then passes through the dispersing portion of the apparatus, which is sufficiently powerful to show distinctly the fine nickel line within the double D line, when it is directed to the sun. The micrometrical arrangement by which the position of the lines is determined will measure the $\frac{1}{2000}$th part of the interval between A and H. Absolute measures would be of little value, unless they were accurately comparable with similar measures of the solar lines. This has been provided for in the apparatus, which is so constructed as to permit the light of any flame to be thrown into the instrument, and its spectrum viewed directly with that of the star. A sodium line thus seen has been selected as a fiducial point of measurement, and its position in the apparatus verified by observations of the sun, when it is found to coincide with D.

Last February a "note" was sent to the Royal Society, containing, as an earnest of the results of the observations of Professor W. A. Miller and the writer, the diagrams of the three stars which accompany this paper.

Previously to this, little advance had been made upon the observations of Fraunhofer, in the beginning of this century. He recognized the solar lines in the spectra of the Moon and Venus; and also measured some three or four lines in Procyon, Capella, Betalgeus, Castor, and Sirius. Donati's recent elaborate paper contains several additional stars, but in no case has he given the positions of more than three or four bars. The investigations of Fraunhofer and Donati were both undertaken to determine if the light from the stars is identical with, or differs from, solar light in its refrangibility. It is believed that the investigations of the writer and Professor W. A. Miller are the first that have been undertaken with a view of determining *the constitution* of the fixed stars. Quite recently three other observers have published results—Rutherford in *Silliman's Journal* for January, 1863; Secchi, in the *Nachrichten*; and the Astronomer-Royal in an oral communication to the April meeting of the Royal Astronomical Society. As the results which these observers have given are inferior in completeness to those arrived at by the writer, he will at once ask the reader's attention to the diagrams of Aldebaran, Sirius, and α Orionis, in Fig. 1.

A single glance will show that the fixed stars have been created upon the same general plan as our sun, and yet that to

this unity of plan is added variety of purpose in the different grouping of the elements composing each. In Aldebaran and *α* Orionis will be seen a line coinciding in position with D, and indicating the presence of sodium in these stars. In Capella, Arcturus, and other stars, a sodium line is also present. In Capella, the writer has seen this line to be finely double, as upon close inspection of the solar spectrum in Fig. 1, the line D will be seen to be—a proof that may be considered conclusive of the presence of the metal sodium. The C, hydrogen, line is also present, and this probability is rendered stronger, by a line in each star coinciding with the other hydrogen line F. Amongst some fifty stars observed, a very large number, if not all, have a line corresponding to F. This would show that hydrogen—the element upon this earth, next to oxygen, perhaps, the most widely present, and equally essential with oxygen to the structure of everything that has life—is also very widely diffused through the universe. Magnesium and iron would seem to be present in a large number of stars.

The writer and Professor W. A. Miller consider the direct observation of the coincidence of stellar with metallic lines so important, that they intend not to rely upon measures, but to compare the metals directly with the stars. This has already been done with some metals.

It must be remembered that a few only of the lines seen are laid down in the diagram. Most of the star spectra appear to be as full of lines as is the solar spectrum. Other lines have been seen in Sirius, in the orange and in the green.

If these distant suns have thus an analogous constitution with our sun, may we not suppose that the planets which, doubtless, they uphold and energize, are of like material structure? And if terrestrial elements, with their properties unchanged, be present, may we not further surmise, that life in forms not wholly dissimilar to those on this planet, and which these elements are so eminently adapted to subserve, may not be wanting. The spectrum of solar light reflected from the planets has also been observed. Numerous lines have been measured in the spectra of Venus, Jupiter, and the Moon. They have also been recognized in Saturn and Mars. No addition or change of lines has been seen to indicate that the light has undergone any change by reflection from them. It is probable that, with the exception of the Moon, we receive the light reflected from clouds or vapour in the atmosphere of the planets, and not from the true planetary surface. The light would not, under these circumstances, pass through so great a length of planetary atmosphere, and in the same proportion would it be less liable to have any modification impressed upon it.

TEMPERATURE OF THE SUN AND STARS.

Besides the light of the sun, which, when spread out, forms the visible spectrum, the sun sheds upon us a large amount of energy invisible as light. Professor Stokes's investigations have shown that this invisible energy, when passed through a prism of quartz, is spread out like light, and contains lines or spaces where this energy is absent, similar to the dark lines in the visible spectrum. By the substitution of a collodion plate for the eye, Professor Miller has investigated the invisible

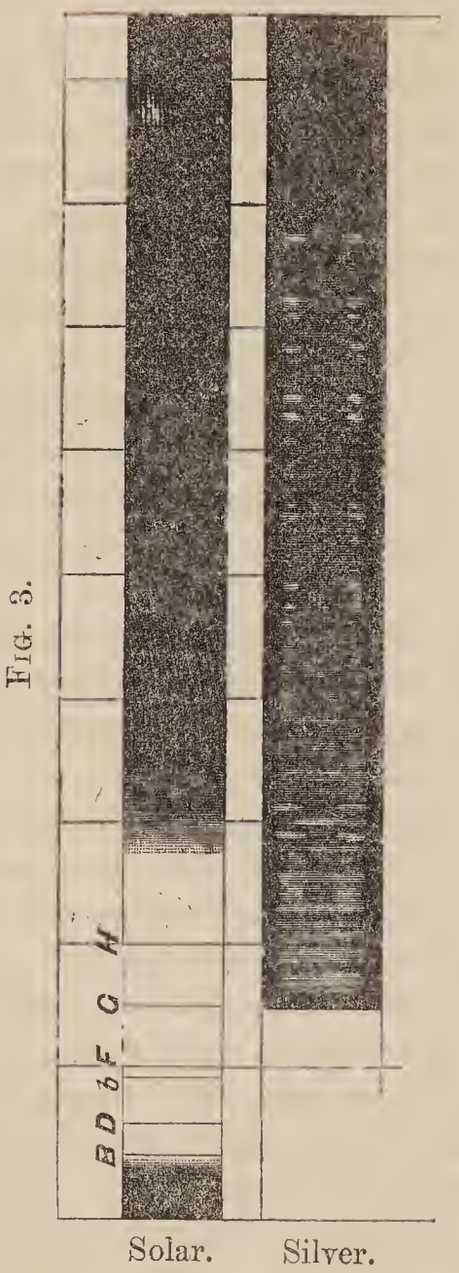


Fig. 3.

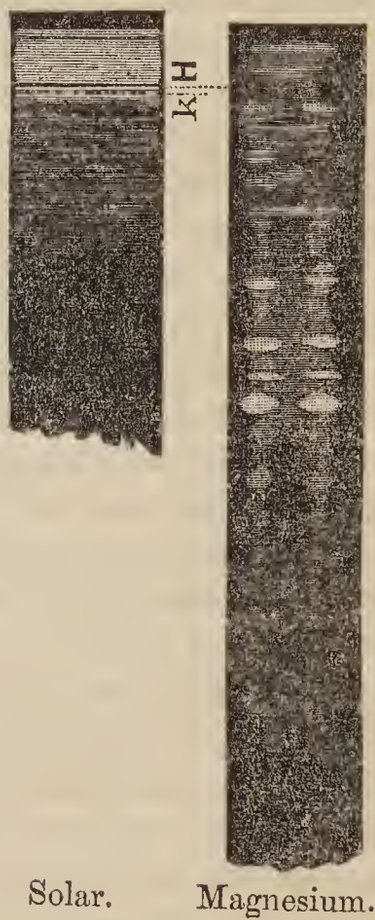


Fig. 4.

spectra of metallic flames. These are as distinct and characteristic of each metal as is the light spectrum of each. In Fig. 3 is given an engraving of the photographic impression of the invisible spectrum of silver, which is seen to extend many times the length of that portion of the visible spectrum which is actinic enough to record itself upon the plate.

Observation has shown that the length of these spectra of invisible energy and their lines are closely connected with the temperature of the source of heat. In Fig. 4 are given

representations of photographs of the refrangible portion of the solar spectrum, and of that of the metal magnesium. Though these have not been reduced to the same scale, the impression is a correct one, that that of magnesium extends much beyond the solar, and especially will it be noticed, is there a remarkably strong band in the magnesium spectrum just beyond the limits of the solar. Yet no metal has been proved to be present in the sun with more certainty than magnesium. Professor Miller regards this difference as an indication of the solar temperature. The magnesium spectrum was obtained by the electric spark. If, in place of this intensely high temperature, the oxyhydrogen flame of only 15°000 F. be substituted, the magnesium spectrum is shortened, and does not extend beyond that of the sun. From this Professor Miller infers that "the temperature of the sun may be approximately estimated to be not higher than that of the oxyhydrogen flame. It certainly appears to be far below that of the electric spark." This seems to be scarcely in accordance with the known law of the decrease of radiant heat. This decreasing, inversely as the square of the distance, gives an intense amount of heat to the solar surface. Waterston, in a communication to the Royal Astronomical Society in February, 1860, states that his experiments, founded upon the supposition that the difference between the temperature in the sun and the temperature in the shade, is a function of the sun's absolute temperature, give above "ten million degrees, probably twelve million, Fahrenheit," to the solar surface.

Is it not possible that vapours may exist in the solar atmosphere which, as Professor Miller shows to be the case with sulphuretted hydrogen, are but imperfectly diactinic, and so arrest these extreme rays of energy? Not that sulphuretted hydrogen, or any compound body, can be supposed to exist upon the solar surface. The elements there must stand too much aloof, by the mutual hate of the fierce heat, to unite themselves in alliances with each other. It may be, however, that conditions unknown to us alter or modify the terrestrial law of decrease of heat.

It seemed, however, an object of great interest to know if similar photographic spectra could be obtained of the stars. The writer and Dr. Miller have already been successful in photographing the more refrangible portion of the spectra of Sirius and Capella. The further prosecution of this investigation is necessarily deferred for the present.

"One star differeth from another star in glory, in wisdom hast Thou made them all."

THE FEET OF HYMENOPTERA.

BY L. LANE CLARKE.

(*With a Tinted Plate.*)

It will be difficult to bring the feet of Hymenoptera within the compass of one paper, inasmuch as it is impossible, I think, to look at the claws and legs of these insects without consideration of the purposes for which they are modified and adapted, in the various species of this very numerous tribe.

We have now before us, besides our microscope, the mounted legs of bees, wasps, saw-flies, ichneumons, and ants; the first thing we notice is that the entire leg is composed of five joints, as in the Diptera, but with the *trochanter* divided into two parts, slightly articulated. The tarsal joints are invariably *five*, but differ considerably in length and in the form and number of their appendages. In fact, an intelligent observer will collect most interesting materials for his microscope by examining the legs of Hymenoptera, of which only a few are now figured to give an idea of their variety and strange forms.

Let not even the tiniest gall-fly or ichneumon escape notice, and if you are so fortunate as to possess a "binocular," the legs may be mounted dry on a disk of light green paper, when every spine and hair will be thrown up round and distinct under the deflected light.

For transmitted light, and the polarizing apparatus, these feet and legs must of course be mounted in balsam, and the legs of bees will require long soaking in potash, or a week at least of hydrochloric acid, to bleach them.

The hind leg of a bee is so well known with its basket and brush, that we need not do more than advise the mounting of the hollowed tibia, and the dilated first joint of the tarsi, edged with strong curved bristles, on the outer side of which is the collecting brush, having *ten rows* of *hairs*, and from sixteen to twenty-four hairs in each row (Fig. 1). But, having mounted the hive bee's leg, there will be a most interesting variety in those of the small humble bee, carder bee, and leaf-cutter bees (*Megachile*). The spines upon the tarsal joints, and the different arrangement of hairs in the brush, are worthy of attention. The pulvillus and claws of the hive bee should be taken from young ones just hatched, being more transparent then. The membranous sucker is folded up when at rest, and inflated into a cup-like disk, edged with adhesive hairs, when the foot is in action (Fig. 1).

Nor should the anterior legs be neglected, for they have in most bees a very curious *notch and spur,* unmentioned in popular bee-books. The hive bee has a deep notch on its fore tarsi, edged with short hairs, and above, on the extremity of the *tibia,* a moveable spur, strong and sharp, which forms a handy pair of pincers, and which I have seen used very effectively under certain circumstances (Fig. 2). When the honey-bees drag a dead intruder from the hive, they use their foot, jaws, or mandibles only; but when they fight a wasp, or expel a refractory drone, they use their fore-leg to clasp and hitch into that notch a leg of their opponent, neither drone nor wasp having the same useful appendage to make the fight an equal one.

In the fore-leg of the *Bombidæ*—humble-bees and carder-bees—the notch and spine are still more developed (Fig. 3). The spur has a strong sharp point, and a horny blade like a pocket-knife, the very thing these little workmen needed for hackling their moss, and building their cells.

The pretty spotted bee (*Melecta punctata*) which hovers over the bright furze blossoms from March to June, has a winged spine on its fore tibia, and the tarsi are beautifully pilose, as if silvered with delicate metallic hairs (Fig. 4); the claws are deeply toothed, the pulvillus very distinct, and mounted dry on a disk of blue paper it is a beautiful object for the binocular.

The leg of *Mesotrichiæ* (Fig. 5) is given merely as an example of variation, for which there is doubtless reason good in the habits of the bee. It is a South American insect, and builds in cavities near the summit of trees. The strange dilatation of the basal joint of its tarsi and curled tufts of hair, as well as the strong spine on the third joint, and triangular tufts of hair, are very remarkable.

The curious feet of *Dryinus cursor* (Fig. 6) are figured to show the position of claws and pulvillus. The fore tarsi have only a single claw, serrated and reflected backwards, whilst the pulvillus is inflated and porrected forwards. The hind tarsi have two small claws, much dilated at the base, and a very large pulvillus. The entire insect should be mounted in balsam. This small ichneumon may be taken from June to August; the females are apterous, the males look like winged ants running over the herbage.

The small ichneumon, *Smiera,* has most singularly curved tibia and tarsi (Fig. 7). This fly may be taken on the banks of ponds and quiet rivers, where it hovers watching for the larvæ of Strationidæ, in which it deposits its eggs. The *Stratiomys* is a black and yellow fly, which passes the first part of its existence as an aquatic larva, with a beautiful apparatus

for breathing—a coronet of hairs terminating its body, which is spread out like a star on the surface of the water, and enables the insect to take in a full supply of air.

But it is in the family of the Fossorial Hymenoptera that the strangest form is found. The *Crabro cribrarius* has a dilatation of the fore tibiæ and tarsi into a concavo-convex plate, apparently soldered on these joints; it is pierced with small dots, each covered with a transparent membrane, which is capable of inflation and adhesion, probably for the same purpose as the sucker on the foot of the male *Dyticus* (Fig. 8). This insect haunts the umbelliferæ in July and August.

The *Ammophila campestris*, another of these burrowing wasps, besides some strong hooked claws, possesses a remarkable toothed spur at the lower end of the fore tibia, and the upper tarsal joint is edged with stout bristles (Fig. 9). Now I doubt not that these act as rakes, and also as grapples, for the work of this fossorial insect is by no means easy. I well remember lying under an apple tree at Woodlands one hot summer's day in July, my eye was attracted by a wonderful orange-coloured creature toiling across the gravel walk, dragging a fat grass-green caterpillar. I was a child then, and knew no scientific names; the romance of natural history was my delight, and so I watched the progress of this poor caterpillar in its enemy's jaws. The larva writhed, and twisted, and clung to every pebble on its way, and the fierce Ammophila tugged, and pulled, and got it along somehow, over the gravel, and on to the flower-bed beside me. Then it dropped the caterpillar, which only faintly tried to crawl away, and had not time to move an inch before back came the fly, which had removed a pellet of earth close by, and discovered a deep-looking hole. This was, doubtless, her nest, and seizing the caterpillar she began to back into the aperture; the fat grub was hard to manage, but the legs and feet of the *Sphex* were set firmly against the sides of the tunnel, these spurs erect, doubtless, and forming a strong finger or toe behind the tarsal joints, which gave her good help in the descent, for, more speedily than I could have believed, they both vanished from my sight. About two minutes elapsed, and the Ammophila re-appeared, quickly replaced its pellet, and concealed the aperture so effectually that I could not find it when, after watching the flight of the insect for a moment, I turned to examine the nest.

This Ammophila was not so obliging as the one observed by Ray in 1667, who, after building in and treading down the earth within its burrow, brought two fir leaves and marked the spot, which enabled him to investigate the contents of her excavation.

Feet of Hymenoptera.

Amongst the Crabonides is a foot reversing all ordinary rules, belonging to the *Mellinus*, a sand wasp. Here the pulvillus is a large sucker on the *apex* of the claws (Fig. 10), instead of between them or under them. There is a reason good for this; the *Mellinus* provisions her nest with living flies, and a big blue-bottle by no means suffers himself to be quietly dragged into the dismal den where voracious young grubs await it; a fierce battle ensues, and even when so far overcome as to yield, and go struggling down, I can understand how useful to the Mellinus these suckers on the *knuckles* may be, in a difficult descent wrestling with its victim.

The legs of the tenthredo or saw-fly are easily mounted, being naturally transparent, and are particularly useful for examination of the joints; not only can the ball and socket between the tibia and tarsi be observed, but the muscular ligaments are often perfectly discernable in a well-mounted specimen (Fig. 11). The spurs, however, constitute its beauty, hanging in lobes from each joint of the tarsi. These little organs inosculate each in an appropriate socket, and have a degree of motion; they are also provided with a kind of sucker or pulvillus, which assists the insect in climbing and clinging to the twigs when the abdominal muscles are in full play during the preparation of its nest. Observe the position of its body upon an upright rose twig or gooseberry branch, the working of its saws with double-action blades, the whole frame quivering with exertion, and kept steady by these adhesive tarsi.

In May and June these saw-flies are common in every garden, and may be caught in the act of preparing the furrow from whence so many little hungry green larvæ will issue forth to desolate our fruit-trees.

Yet the Hymenoptera, as a class, are the ablest and best friends of man, and we may look gratefully as well as admiringly at the tiny feet. The honey-bee is an universal favourite; I never heard it maligned but once, when a crabbed old Cockney, who had retired to his country box, adjoining our residence, sent in a note requesting us to remove our bees, as they quite spoilt his (the Cockney's) flowers. But the rest of the tribe are not sufficiently appreciated, nor the immense importance of such avengers as the ichneumons and the *Sphecides* in keeping down hosts of caterpillars. What should we do with the larvæ of the *Pontia brassica* if we had not the busy little *Microgaster* to stop their increase with her own maternal instinct. These small caterpillars, like many others, eat daily twice their own weight of leaves, as if an ox, weighing sixty stone, were to devour every twenty-four hours three-quarters of a ton of grass; and when we remember that each of those innocent-looking white butterflies, flitting over the cabbage-bed,

will deposit 1,600 eggs, we have reason to be grateful for the little friend whom God has sent to keep in check the voracious depredators; twenty-five out of every thirty caterpillars are destroyed by it. We all know the pest of our rose-trees, the little aphides, *one* of which in five generations is the progenitor of 5,904,900,000 descendants! These are followed persistently by the small ichneumon, *Aphidius avenæ*, and destroyed.

Does not the farmer tremble when in a July evening he sees the yellow *cecidomyia* hovering over the wheat ears? If he looked closer, he would see a small black ichneumon (*Platygaster*) following the track of the midge, and quietly dropping its own egg in the newly-hatched larvæ, which will stop further mischief for this time.

The clover-worm hides in vain in the legume of the plant, and the wire-worm in the earth. The hymenopterous enemy finds out the vulnerable spot, and saves us from our unseen and often unsuspected foe. *Pompilius* and *Pimpla manifestator* keep down spiders and various voracious grubs, whilst the much abused wasp rids us of innumerable flies.

THE PRECESSION OF THE EQUINOXES, AND APPARATUS FOR ITS IMITATION.

BY THOMAS W. BURR, F.R.A.S.

The places of the fixed stars are necessarily designated by two co-ordinates, and those generally used are known as Right Ascension and Declination.

The former is the distance from a fixed point in the heavens, called the First Point of Aries, being one of the two places where the equinoctial and ecliptic cut one another; such distance being measured from west to east along the equinoctial, and reckoned either in 24 hours or 360 degrees. The two points of intersection of the circles called the ecliptic, or the sun's apparent path in the heavens, and the equinoctial, or earth's equator projected to the celestial vault, occur in the signs of the zodiac, Aries and Pisces; and the intersections or nodes mark the first points or beginnings of these signs. The nodes are also called the equinoxes, because when the sun is situate in either of them, the days and nights upon the earth are equal. The other co-ordinate Declination is the distance of a star from the equinoctial towards either the North or South Pole of the heavens, measured in degrees only, and is distinguished as north or south declination. It is, however, by many

astronomers, and in many catalogues of stars, replaced by North Polar Distance, in which the distance of a star is measured from the North Pole instead of the equinoctial, and carried over that circle to the South Pole. No declination can exceed 90°, but north polar distance may of course reach 180°. It will be seen that right ascension in the heavens answers to longitude upon the earth; while declination corresponds with latitude. It may here be noticed that there is a celestial longitude and a celestial latitude, which, however, are reckoned along and from the ecliptic instead of the equator, and therefore do not correspond to the terrestrial elements of the same names; but celestial latitudes and longitudes are only used for special purposes. These elements, right ascension and declination, having been in use for centuries to describe the positions of the stars, it becomes an interesting subject of inquiry to know whether the stars really retain the same precise positions when observed at different times; and although it is obvious that they preserve their *relative* places unchanged, the constellations presenting the same appearance to us as to the earliest observers, still it is found, as the result of the most delicate and careful observation, that the co-ordinates of the place of a fixed star do suffer some slight alterations from time to time, and modern astronomy has succeeded in proving the existence of four distinct corrections necessary to be applied to the observed places of stars, to reduce them to a standard right ascension and declination, or north polar distance. When these alterations are investigated, it is found that they are of two distinct kinds, and are in no case due to the motion of the stars themselves, but either depend upon real alteration of the position of the axis of the earth (upon which the observer is located), in space, or are purely optical in their character; so that the stars again become entitled to the appellation "fixed," which they seemed in danger of losing.* If we look a little closer into the matter, we shall find that there are two apparent motions of the stars due to optical causes. First, the effect of our atmosphere upon the stars and other heavenly bodies, called Refraction, which, by bending the rays of light coming from those luminaries, produces an apparent elevation of them above their real height from the horizon, and which varies with such altitude, amounting to more than half a degree at the horizon, a quantity equal to the diameter of the sun or moon, and thus causing them to be seen when they would otherwise be invisible to us; being only one minute at

* This general statement requires qualification in the cases of those stars proved to have what is called proper motion, but as the cause of this may probably be in most instances the motion of our sun and solar system in space, it has not been thought necessary to make the exception, beyond this note to show the point is not overlooked.

45° of altitude, and diminishing to nothing at the zenith. The correction to be made for this elevation is obtained from tables of refraction, which give the deduction to be made from apparent altitudes, due to the stars' height and the varying state of the barometer and thermometer at the time of observation.

The second alteration of an optical character is that due to the effect known as the Aberration of Light, by which the rays proceeding from any heavenly body become disturbed in their passage, in proportion to the relative velocities of light and of the earth, to which such rays are travelling; and as these velocities are as 10,000 to 1, the result is that the light reaches us in the direction of the diagonal of a parallelogram, having sides of those proportionate lengths, and the stars are displaced about 20″ in different directions, as the earth travels in its orbit round the sun in a year, the apparent place describing a small ellipse round the real place. This apparent alteration is also readily eliminated by the proper correction; for the application of which directions are given in all astronomical catalogues.

The remaining two changes of place in the stars are much more important, and, forming the principal object of the present paper, will require greater detail in their treatment. They are called the Precession of the Equinoxes, and the Nutation of the Earth's Axis. Unlike refraction, which is a variable element, and aberration, which is constant in quantity, and completed annually in the small elliptical motion we have described, the motion affecting the places of the fixed stars, called precession, is constant in its character and accumulative in quantity, until completed in a cycle of enormous length. Its discovery took place more than 2000 years ago, by the celebrated Greek astronomer, Hipparchus, but the cause remained unknown till explained by the surpassing genius of Newton. Hipparchus, when ascertaining the place of the equinox at Alexandria, by observations of the time when the sun had no declination, found that the point so ascertained no longer corresponded with the place indicated by the still older observations of Aristillus and Timocharis, made 150 years before, but had shifted about 2° to the westward; and following up this discovery for thirty years, he found that the equinox moved westward about a degree in every seventy-five years, and he likewise found that this change involved a corresponding alteration in the places of the stars, whose right ascension being measured from the vernal equinox as a starting point, would necessarily have their distance from such point increased by the retrograde motion in question, as the earth in its rotation would have to turn further on its axis from the first point of Aries, before it had any particular star on the meridian (which indicated the

right ascension of that star), than it had to turn the year before, because in the year the first point of Aries had been shifted to the westward. This may be illustrated by supposing a road running east and west, and a carriage crossing it at a certain point; then the distances of all houses, churches, trees, or other objects to the east of that crossing, and measured from it, would be altered and increased if the carriage, after taking a sweep round, returned, and crossed the road at a place a little to the westward of its previous passage, although the relative distances between the objects themselves would remain the same. Notwithstanding the motion, being from east to west, contrary to the planetary motions in general, is really a retrograde one, it is called The Precession (or acceleration) of the Equinoxes, as, by carrying the node to meet the sun, it makes the equinox occur earlier than it otherwise would, and makes the solar year 20 minutes 22·9 seconds shorter than the sidereal one, the former being measured by the passage of the sun from one of the equinoxes, and the latter, by its journey from a particular star, till it arrives at the same equinox, or star.

The effect of precession, though small in each year, and altering the first point of Aries only 50″·3 annually, by its continuance produces great changes. Thus the signs of the zodiac (that is, the portions of 30° each into which it is divided, and through one of which the sun travels in a month), when originally named, coincided with the constellations of the same names, and the intersection of the ecliptic and equator, called the First Point of Aries, was really at the beginning of that constellation; but Hipparchus found that even in his time they no longer agreed, and in the two thousand years that have since passed, the difference has so accumulated that the signs and constellations of the same names are more than a sign, or 30° apart, and the first point of the sign Aries is in the constellation Pisces; the first point of Libra in the constellation Virgo, the tropic of Cancer in the constellation Gemini, and that of Capricorn among the stars of Sagittarius.

The fact was thus known and estimated, but the cause remained undiscovered until the grand generalization of gravitation was announced by Newton. He arrived at the theoretical conclusion that the earth was not a perfect sphere, but flattened at the poles, which subsequent accurate measures showed to be correct. The equatorial diameter is twenty-six miles greater than the polar, producing a ring or belt of matter thirteen miles high at the equator. Now as, according to the law of gravitation, every particle of matter in the universe attracts every other particle of matter, wherever situate, with a force directly proportioned to their mass, and varying inversely as the square of their distance; the sun and the moon, both

large masses of matter, and comparatively near the earth, act powerfully on it (the sun's attraction, in fact, keeping the earth in its orbit); but as there is more matter at the equator than elsewhere, and this projecting matter is nearer to the sun and moon than the matter at the centre of the earth, the projecting portion is more strongly attracted than the centre, and by its endeavour, in conformity with this attraction, to approach the sun and moon, tilts the equator a little out of its position, and this tilting, modified by the earth's rotation, causes a corresponding motion of the equinoctial points, which, being the places where the equator and ecliptic cut each other, must necessarily move if either of those circles shift its place. Nor is the motion of the equator the only one. This part of the earth cannot move without the rest of the globe. The earth's axis, which may be imagined as passing through it like a bar of iron from pole to pole, and stretching to its vanishing points in the heavens, must move too; and this effect also was early noticed, viz., that the place of the pole in the sky did move, and that it was clearly the direction of the pole that changed, and not the stars themselves. Precession, therefore, alters the declinations of stars as well as the right ascension. In some cases it increases this element, in others it diminishes it, the amount varying, but never exceeding, 21″ per annum. Thus, at the time of the earliest catalogues, our present pole star could not have fulfilled that office to the observers of that time, as the earth's pole pointed 12° away from it. The Pole Star, *α* Ursæ Minoris, is now only $1\frac{1}{2}$° from the North Pole, and will approach to within half a degree of it, after which it will recede, and in twelve thousand years Vega *α* Lyræ will be the pole star, being then only 3° from the earth's pole; so, too, about four thousand years ago, *α* Draconis was the earth's north pole star, though now many degrees distant. If the path of the pole be traced out among the stars, it will be found that this extremity of the earth's axis moves in a circle of $23\frac{1}{2}$° radius round the pole of the ecliptic, which extensive sweep is due entirely to the Precession of the Equinoxes. The rate of motion is very slow; it has taken two thousand years to move 33°, and will be about twenty-six thousand years (25,868) going completely round. The pole, like the equinoctial points, moves from east to west, contrary to both the earth's motions, orbital and axial. The precession of the equinoxes is intimately connected with the other motion to which we have alluded, as altering the places of the fixed stars, although not due to any real change of place in them, but to the motion of the axis of the earth on which the observer is placed, and which remaining motion is called the Nutation of the Earth's Axis. The alteration produced by it is very small indeed, and our knowledge of its existence is a

result of the delicate and masterly observations of Bradley, one of the greatest astronomers of modern times, to whom we are also indebted for the discovery and explanation of the aberration of light. Bradley was engaged in researches having for their object the discovery of the parallax of the stars, and hence their distance from the earth, and was working upon the star γ Draconis, which daily passes the zenith of London, and although disappointed in his original object, he observed such a motion of the star as led him to the discovery of nutation. To explain his observations, we must remind you that precession is due to the greater attraction which the sun and moon exert on the protuberant equatorial belt of the earth than they do upon its central portion, and upon the central part than upon the parts further off, and that this attraction, or pulling, which would be ineffective except as to tidal movements upon a sphere, when exercised upon a spheroid by the sun, when above or below the equator, has a tendency to pull the equatorial belt towards it, and thus bring the earth's axis more nearly perpendicular to the ecliptic; but this effect being modified by the earth's rotation on its axis, results in bringing the equator to meet the ecliptic at a point earlier than it otherwise would. Now it is obvious that this disturbing force of the sun must be greatest when it is at either of the solstices, or points of extreme distance from the equator, and nothing at all when the sun is at either of the equinoctial points, where the sun, being in a line with the equator, there would be no tendency to produce tilting of the earth's axis. Precession, therefore, goes on more rapidly in summer and winter than at other times, and this irregularity in its rate constitutes Solar Nutation. There is a similar small irregularity occurring every month, due to the varying position of the moon above and below the earth's equator, which is one part of Lunar Nutation, but the effect of both these causes is almost inappreciable, not exceeding an alteration of half a second of arc in each case.

The principal part of the nutation of the earth's axis, which is caused by the moon, occurs in this way :—The moon produces a much larger part of precession than the sun does, although the moon is so very much smaller than the sun, being equal to only $\frac{1}{20,000,000}$th part of the sun's mass. She is, however, 400 times nearer than the sun, and this makes her whole attraction, in proportion to her mass, 160,000 times as great as the sun's; still her whole attraction is only $\frac{1}{120}$th of that of the sun. But the important thing to be remarked in the explanation previously given is, that precession is not produced by the whole attraction of the sun or moon upon the earth, but by the difference between the attractions which they exert upon the earth's centre and upon the earth's nearest surface. For the moon,

the proportion of the distance of these parts is nearly as 60 to 59, and then the difference of the attractions is about $\frac{1}{30}$th of the whole attraction of the moon. But, for the sun, the proportion of distances is nearly as 24,000 to 23,999, and then the difference of the attractions is about $\frac{1}{12,000}$th of the whole attraction of the sun.* The consequence is, that the difference of attractions of the moon is actually three times as great as that of the sun, and the precession produced by the moon is three times as great as that produced by the sun. Now the moon's orbit does not coincide with the ecliptic, but is inclined to it at an angle of 5°; and this orbit, from the disturbing effect of the sun's attraction, moves so that its nodes or intersections with the ecliptic travel entirely round in the space of nineteen years, preserving its constant inclination of 5°. The earth's equator is inclined to the ecliptic at a constant angle of $23\frac{1}{2}°$, and therefore the inclination of the moon's orbit to the earth's equator is constantly changing, and the moon's orbit is, for half the nineteen years, very little inclined to the earth's equator, and for the remaining half is very much inclined to it. In the former case, precession goes on very slowly, and in the latter very rapidly; and this irregularity in the rate constitutes the great part of lunar nutation. The tilting of the axis from side to side of its normal position is modified by the earth's rotation into motion in a small ellipse, having a major axis of 18″, which is completed in about nineteen years. Bradley, in fact, found that the star γ Draconis continued to move north of its proper place from 1727 to 1736, a motion totally inconsistent with parallax, which would have been complete in a year; and having formed his hypothesis of the cause, he continued his observations, and found the star then returned, and went south for nearly ten years, so that in 1748 he was enabled to announce his discovery of the nutation (or nodding) of the earth's axis. The effect of this nutation, if existing alone, would be the motion of the earth's pole in the small ellipse previously described; but, as precession is going on at the same time, and carrying the pole of the earth round the pole of the ecliptic in a circle of $23\frac{1}{2}°$ radius, the two motions become compounded, and the result is an undulation of the precession curve, the small ellipses of nutation never being completed, but the motion of the pole turned into an undulatory circle instead of a uniform sweep round the ecliptic pole.

As the precession of the equinoxes alters the places of the

* For these proportions, and the general idea of the treatment of the causes of the motions of precession and nutation, the author is indebted to Airy's Ipswich *Lectures on Astronomy*, a work which is unrivalled for the lucidity and completeness of its explanations, and is invaluable alike to both student and teacher.

stars so materially, it becomes necessary, in constructing catalogues and maps of the stars, to name the precise period or epoch at which they represent the places; and this is done by affixing the proper date of the catalogue or map to which all the observations have been reduced, and then by adding to the lists of the stars' right ascensions and declinations other columns showing the annual variation in these co-ordinates caused by precession, the place of each star can be calculated for any other time, either before or after the catalogue epoch.

From the preceding explanation of the motions of precession and nutation, which has been given in the simplest form possible, it will be seen that the subject is one presenting some difficulty in its conception to the non-mathematical student; and even with the aid of diagrams the difficulty is not readily obviated. It has therefore always been a desideratum to obtain for educational purposes some piece of mechanism which should imitate the motions in question, and render tangible that which had to be comprehended by the mental faculties. Accordingly, Bohnenberger, the late Professor Baden Powell, and others, have devised such pieces of apparatus, in which a conical motion of an inclined axis round a perpendicular was obtained, but an exact representation of the earth itself was not attempted.

About nine years since, the writer having occasion to explain these motions to a popular audience, contrived an apparatus for the purpose of illustration, which is admitted to imitate them perfectly, and which having been found extremely useful by him, and the limited circle to whom it has hitherto been known, is now made more generally public.*

Its conception was founded on two well-known data. First, it has long been known that the motions of a child's top in spinning afford an excellent illustration of the conical movement of the earth's axis in precession, although, from the force being opposite in character, the tendency there is to increase the distance between the axis of the top and the perpendicular to the horizon, while in the earth's case the tendency is to bring the axis of the earth nearer to the axis of the ecliptic; still the tilting force, modified by rotation, produces in the axis of the top while spinning a motion describing a cone round the perpendicular, preserving (until near the end of its spin) the same inclination; but in this case the motion is in the same direction as that of the rotation, instead of being the reverse, as in precession, and the analogy, therefore, here fails. The

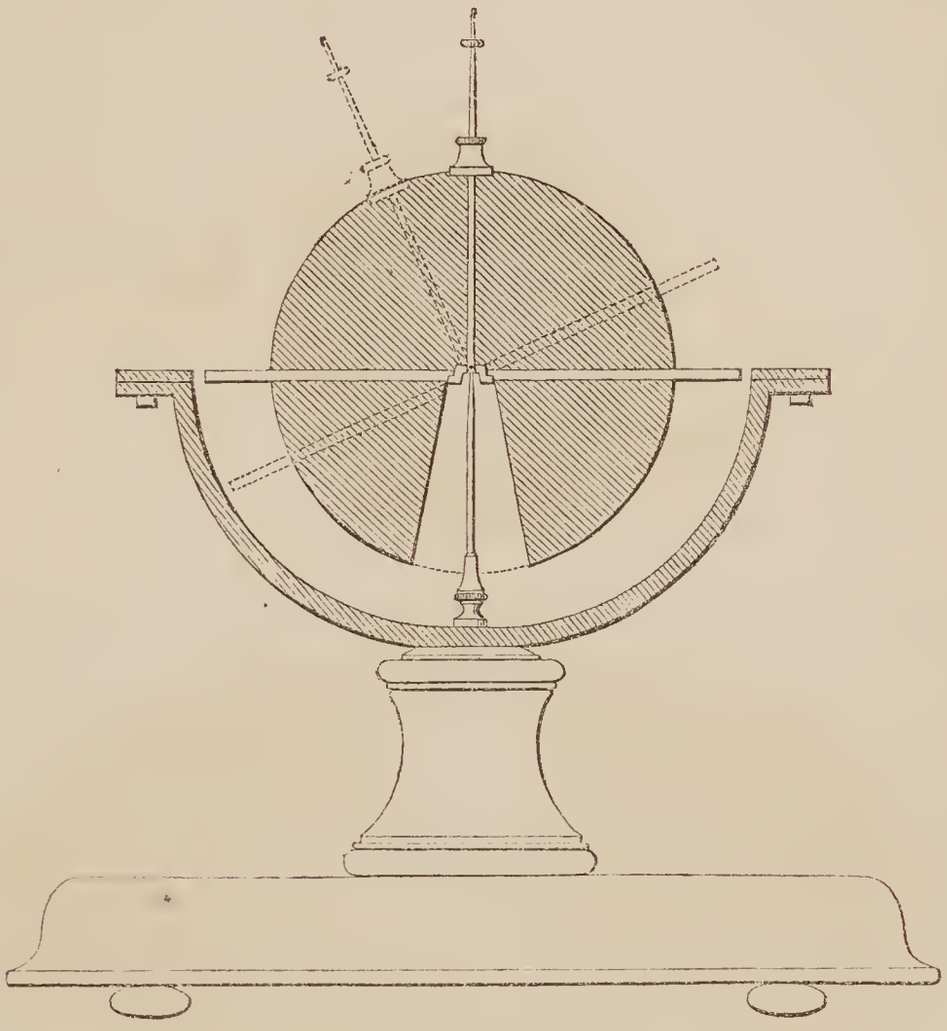
* It has only been previously described and figured in the monthly Notices of the Royal Astronomical Society, vol. xv., and in Worms' excellent work, *The Earth and its Mechanism.*

second principle of the author's apparatus, however, removes this difficulty. It had been shown by Mr. Atkinson, in the first volume of the monthly Notices of the Royal Astronomical Society, that by altering the position of the centre of gravity with respect to the point of suspension in a rotating disk, the conical motion could be made to coincide with, or be the reverse of, that of rotation. Guided by these principles, and adding such improvements as would more effectually represent the real motions of the earth, the apparatus shown in elevation and section by the accompanying engravings was constructed. It

PRECESSION APPARATUS, FIG. 1, ELEVATION.

consists of a small terrestrial globe, having a brass disk passing through the centre, and representing the equator projecting from the globe. The base of the globe is hollowed out, to allow its suspension on a point which rises in the interior to the level of a horizontal graduated circle, representing the ecliptic. Through the upper hemisphere runs a steel axis projecting above the North Pole, and terminating in a cup at the middle of the globe, which axis is capable of being raised and lowered by a screw motion in the brass socket at the

pole.* If now the axis be so adjusted that the point of suspension is above the equatorial disk, and consequently above the centre of gravity, and the globe be rotated rapidly from west to east, by winding a silk cord round the axis, and spinning it like a top, it will be seen that while the rotation from west to east on the axis imitates the diurnal motion of the earth, there is also generated a slow conical movement of the projecting axis round the pole of the horizontal circle, representing the ecliptic, in a direction opposite to that of the diurnal rotation, that is, from east to west; and that the equinoctial points or intersections of



PRECESSION APPARATUS, FIG. 2, SECTION.

the equator and ecliptic move slowly round in the same way. It is necessary that either a small weight should be attached to the equatorial disk, which may be done by putting a little piece of brass on a pin, or the equator may be made to preponderate a little on one side, or a simple inclination of the axis at starting will suffice to produce the precessional motion; but it is better to have the equator slightly weighted on one side, as in this case it is found that besides describing the circle representing precession, it will be seen that the projecting axis

* Mr. Hislop, of 108, St. John Street Road, constructs the apparatus.

performs a number of minute oscillations, or noddings, which render the principal curve undulatory in character, and give a perfect imitation of the nutation of the earth's axis, as well as of the precession of the equinoxes.

By carefully adjusting the distance between the point of suspension and centre of gravity, the rate of the motion can be adjusted to any desired proportion between it and the rotatory movement; and of course by lowering the centre of gravity, the directions of the two motions may be made to coincide as in the spinning top; while by getting the two points to meet at the same place, the tendency to conical motion is neutralized, and the rotating globe can then be carried round a central ball or lamp, representing the sun, with its axis constantly pointing in one direction, affording an illustration of the parallelism of the earth's axis, producing the phenomena of the seasons, thus rendering the apparatus useful in another way, as well as in its original purpose of exemplifying the mechanical principles which produce the important phenomena of the Precession of the Equinoxes.

MICROSCOPIC PURSUITS.*

The highly successful efforts of many opticians in London and elsewhere, to make good and cheap microscopes, have supplied thousands of individuals and families with the means of perpetual recreation of a scientific kind, and we are glad to observe the publication of numerous works calculated to suit the wants and the pockets of those who may be disposed to let amusement and improvement go hand in hand. To gaze for a few moments at a well prepared slide, or at a small natural object, placed on the stage of a microscope, is an agreeable, but very transient and unsatisfactory employment, unless the observer knows the character and uses of the structure he sees; and hence there is no possibility of deriving permanent pleasure from such a source, without taking the trouble to become acquainted with at least the elements of many branches of knowledge. We recently heard a gentleman, who had carried off many prizes in his university career, complain "that the worst of the microscope was, that it required you to learn so much." This is one view of the question; but what, at first sight, appears an objection and a stumbling-block, must be seen upon considera-

* *Objects for the Microscope;* being a popular description of the Most Instructive and Beautiful Subjects for Exhibition, by L. Lane Clarke. Second edition. Groombridge and Sons.

tion to be the highest recommendation to the purchase and use of one of the most admirable instruments that optical art has contrived.

The difficulty of a beginner is not the extent of the subjects that open before him, but how to get at them at all. If money were of no consequence, and he started with fifty pounds' worth of the best books on natural history, botany, physiology, and so forth, his bewilderment would be increased, without his doubts and queries being solved. What is necessary to smooth over the early stages of any scientific pursuit is an elementary guide, suggesting a right method and giving a clear insight into the facts and principles that form the groundwork of the subject in hand. With the microscope there is the additional difficulty that no one branch of study will be properly appreciated without acquiring a rudimentary acquaintance with many more.

For the advanced microscopic student, or for any one who commences the pursuit with a good general knowledge of science, no better book could be desired than Dr. Carpenter's admirable work;* but that which constitutes its great merit for the class for whom it is intended, renders it for a time unsuitable for those whose beginnings must take a humbler form. For these—and their name is legion—the second edition of the little book entitled *Objects for the Microscope*, by L. Lane Clarke, comes admirably into the field. In the less elaborated state of the first edition it obtained well-deserved success, which will be repeated now that the work has assumed—without departing from its original simplicity—a completer form. The book is founded upon a series of objects, nearly all of which may be purchased of the opticians in the form of slides; but its utility is by no means confined to the description of microscopic preparations, as it will suggest to the beginner what may be sought for and collected in any situation, and what may be learnt from it when the microscope is employed. The information, conveyed in popular language, is for the most part amply sufficient for a first lesson, and after it has been pleasantly mastered, the student will find himself materially helped towards understanding the more complete descriptions in formal scientific works, which would be unintelligible if approached without such preliminary aid. The objects described range over a wide area. Three chapters are devoted to the vegetable kingdom, including one that treats of infusorial earths and desmids. Then the animal kingdom is considered in about a dozen chapters, discoursing on a great variety of insects, and the second part describes mollusca, zoophytes, etc., together with

* *The Microscope and its Revelations.* Churchill.

anatomical injected preparations, which have been judiciously selected for popular use, and the whole winds up with a chapter on "Slides of Crystallization." The task thus undertaken has been ably performed. The book will assuredly answer the purpose of securing the interest of a wide range of readers and incipient observers, and tempt many youthful members of society from the pernicious habit of idling away their time. It will also prove an excellent help to those who have undertaken the work of education, and desire to include a knowledge of natural objects in their scheme. We have no hesitation in according to the author our emphatic commendation; but of course it was improbable that so many matters would be discussed without some errors creeping in. One of these we notice in the optical remarks at the beginning, where it is said "that the larger the angle (of aperture of objective) the greater are the number of rays admitted, and the more brilliantly the object is illuminated, *the greater consequently is the defining power.*"

The mistake is in the last words, the fact being that the angle of aperture may be too great in proportion to power, and then definition, except of very delicate surface markings, is actually impaired. No one, for example, would use a quarter-inch objective for general natural history purposes, which had an angular aperture of 150°, as its penetrating power is necessarily less than that of one having an aperture of 80° or 90°, and, consequently, it is only fitted for special use. Beginners also will find large-angled glasses far more troublesome to use than moderate ones, and for the binocular small angles are usually preferred. The chapter on Polyzoa also needs a little revision. It is too much to say that "almost all the Polyzoa have calcareous sheaths;" many are horny, or membranous, and some, like the alcyonidiadæ, fleshy and cartilaginous, while the pedicellinæ have no cells distinct from the skin. It might also lead to error to speak of these creatures as "strictly solitary individuals," "though always found in a mass." They are intimately connected, and, as we explained in vol. ii. p. 67, Dr. Fitz Müller has detected in one species what he terms a "colonial nervous system," which he believes the whole class possess.

In microscopic, as in other works, the value of associated labour is soon recognized, and we should recommend every one to persuade a few friends to join in the pursuit. A little society formed of two or three neighbours, who can unite in expeditions for collecting objects, and meet occasionally for the display and discussion of their captures and preparations, not only provides the means of passing many pleasant hours, but lightens the inevitable toil. The Manchester Scientific Students' Association, of which we have just received a Report, is a body con-

ceived in the spirit we recommend. Larger associations have no doubt their uses, but we especially recommend the multiplication of small friendly groups, and we strongly advise all bodies, big and little, which may be united for any scientific object, to endeavour to rescue mechanics' institutions and similar societies from the deplorable plight into which their lecture systems have been permitted to fall. Not to pass beyond our immediate purpose of encouraging microscopic pursuits, let any one consider what help would be afforded if, instead of time and money being wasted on scrap lectures, succeeding each other in "most admired disorder," the leading facts and principles of any branch of natural history could be taught and learnt. The microscopist will soon find that half a dozen lectures on comparative physiology would be invaluable, together with a similar number on zoological classification, and as many on plants. Information of this kind ought to be communicated each year, and brought up to date, in every town of ten thousand inhabitants, that has any pretence to civilization; nor need smaller localities entirely go without a proportionate supply. Parents complain that their girls grow up like empty vessels, and their boys turn dissipated, but they seldom reflect on the needless difficulties that are permitted to obstruct the rational use of their faculties, and on the very slender encouragement which most families give to intellectual pursuits.

NEW THEORIES AND FACTS OF HEAT.*

One of the evils that has resulted from paying too much attention to a class of men called "practical," has been to confuse the general mind as to the meaning of the term "theory." The "practical man," who is often narrow-minded and ignorant, exclaims, on hearing something which he does not understand, "that is all *theory*," thereby meaning guess-work, or fancy, unsupported by fact. The real difference between the so-called "practical man" and his superiors in knowledge is, not that he *does* more than they do, but that he has not, like them, the faculty of perceiving the connecting links which logically tie a whole group of facts together, and lead to the explanation of them all by reference to a common

* *Heat, Considered as a Mode of Motion:* Being a Course of Twelve Lectures delivered at the Royal Institution of Great Britain in the Season of 1862. By John Tyndall, F.R., and Professor of Natural Philosophy in the Royal Institution. Longman.—*Exposition Analytique et Expérimentale de la Théorie Mécha-nique de la Chaleur.* Par G. A. Hirn. Paris: Mallet-Bachelier.

law. So far from the "practical man" being right in his attempt to confuse *theory* with *hypothesis*, he is totally in error, as no explanation of phenomena would be called a *theory* by any sound scientific writer or thinker, unless it differed in certainty very materially from a mere *hypothesis*. We shall not stop to inquire into the advisability of restricting the term "theory" more closely than is usual among writers of authority; but we should fail at the outset of our remarks on the "Mechanical Theory of Heat," if we did not guard against the misconception that all theories are fancies which are of little certainty in comparison with facts. Investigators, who do not proceed at random, assume the existence of a particular property, or the probability of a certain explanation, in order to guide them in their researches, and they then proceed by observation and experiment to ascertain whether their hypothesis is right or wrong. If wrong, they abandon it; if it *seems* right, they endeavour to ascertain whether the apparent correctness is an accidental result, or one necessarily and uniformly arising from a fixed law. In the latter case, they embody the knowledge they have acquired in the shape of *theory*, which explains the group of facts they endeavoured to elucidate; and their theory is just as true as any isolated incident which the "practical man" might be able to see.

Distinguished writers sometimes use the term "theory" in another sense, as when it embodies an explanation that *may* be wrong, but *must* be true, if certain assumed facts should ultimately prove to have a positive existence; and, in this case, the theory differs widely from a mere conjecture, which might be wrong even if the facts assumed as its basis should be established by further research. When, however, we find theory confounded with hypothesis, we may be sure that the individuals so offending have not mastered the rudiments of scientific thought.

The preceding observations will prepare the mind for the investigation of the remarkable facts concerning heat which have been made known during the last few years, through the researches of distinguished men in England and on the Continent, amongst whom Dr. Joule deserves a foremost place. They will also explain the sense in which M. Hirn speaks, when he says, "It should be clear to all that this Mechanical Theory of Heat is not derived from any particular hypothesis as to the nature of heat; but, on the contrary, that every hypothesis ought to satisfy (or conform to) this theory."

In 1863, Mr. John Stuart Mill wrote, in his admirable dissertation on Logic, in reference to the then partially demonstrated speculations embodied in Mr. Grove's "Correlation of

the Physical Forces," that "to prove Mr. Grove's doctrine, heat should be capable of being converted into electricity, electricity into chemical action, chemical action into mechanical force, and mechanical force back again into the very same quantity of heat which was expended at the commencement of the series." Since these words were penned, an immense progress has been made in the collection of the kind of proof which Mr. Mill required, and we are now able to show that "whenever we employ mechanical force to produce a temporary modification in the condition of a body, a quantity of heat is produced proportional to the mechanical force expended;" and that, "for an equal quantity of mechanical force produced on one hand and expended on the other, precisely equal quantities of heat disappear and reappear, whatever may be the substances submitted to the experiment, and whatever may be the changes they undergo; provided always that these changes are only temporary." It also appears that "a given quantity of mechanical force, or work, is equivalent to a constant quantity of heat; and that there is thus a Mechanical Equivalent of Heat, and a Heat Equivalent of Mechanical Force."*

To render this series of facts intelligible, let it be remembered that employing mechanical force by rubbing two bodies together makes them hot, and the quicker and more violently they are rubbed—that is to say, the greater the quantity of mechanical force expended in a given time, the hotter they will become; so that, as many savage tribes know, a fire may be kindled by the sufficient friction of two bits of wood. Here we have an illustration of the production of heat by mechanical force, and it can be shown experimentally that the quantity of heat obtained is always in proportion to the quantity of mechanical force expended in the process. Let us now take an opposite case—that of expending heat and obtaining an equivalent of mechanical work. First, we will consider the internal work done by heat among the atoms of a substance that is made hot. All its particles are moved, and under ordinary circumstances the body is expanded. Professor Tyndall tells us, "The energy of the forces engaged in this atomic motion and interior work is enormous. . . . . A pound of iron, on being heated from 32° to 212°, expands by about $\frac{1}{800}$th of the volume which it possesses at 32°. Its augmentation of volume would certainly escape the most acute eye; still, to give its atoms the motion corresponding to this augmentation of temperature, and to shift them through the small space indicated, an amount of heat is required which would raise about eight ons one foot high!" It is well known that expending heat upon

* Hirn, p. 20.

various bodies does not make them hot in the same proportion. A certain quantity of heat disappears, and used to be called "latent," or hid—a phrase that must now be changed, because we now know that it is consumed in the performance of interior work, altering the position of particles, or forcing them asunder, or both, as the case may be. Water has, for example, thirty times the so-called capacity for heat that mercury possesses; so that a given amount of friction, or mechanical force, only raises water to $\frac{1}{30}$th of the temperature to which it raises mercury. Dr. Joule took this and similar instances into his calculation, and when due allowance was made for the heat which thus disappeared, he found "that the absolute amount of heat generated by the same expenditure of power was in all cases the same."*

Friction is a retardation of motion, and heat is produced in proportion to the quantity of motion thus stopped. Bearing in mind that mechanical stoppage of motion produces heat, we shall be prepared to find that when a target stops a rifle or cannon ball, both ball and target are made hot; and in a smaller degree, because the amount of arrested motion is less, when a weight falls to the ground from a moderate height, the ground and weight are heated in proportion to the velocity of the fall. If the fall of the weight—a cannon-ball, for example—were from a great height, so that its accelerated velocity equalled that of a similar cannon-ball fired from a gun, an equal heating effect would be obtained. Now Dr. Joule ascertained that "the quantity of heat which would raise one pound of water one degree Fahrenheit in temperature is exactly equal to what would be generated if a pound weight, after having fallen from a height of 772 feet, had its moving force destroyed by collision with the earth. Conversely, the amount of heat necessary to raise a pound of water one degree in temperature would, if applied mechanically, be competent to raise a pound weight 772 feet high, or raise 772 pounds one foot high."† Thus, the mechanical equivalent of heat is obtained, and, for convenience in England, we calculate it from the quantity of heat which will raise one pound of water one degree of Fahrenheit's scale; though, while we do so, we regret that our pound is not like the decimal measures of our neighbours, a rational quantity, and that our thermometers are graduated according to an inconvenient scale.

The velocity of bodies falling to the earth is known to augment as the height from which they fall is increased, but not in simple proportion. "If the height be augmented four-fold, the velocity is only augmented two-fold; and if the height be

* Tyndall, p. 39. † Tyndall, pp. 39, 40.

increased sixteen-fold, the velocity is only augmented four-fold; but the heat generated by the collision of a falling body increases simply as the height, and consequently as the square of the velocity." Thus trebling the velocity will yield, on arrest of the motion, nine times the heat. Every one knows that when the break is applied to the wheel of the railway carriage, the stoppage of motion is accompanied by a great evolution of heat; and as the weight of the earth is enormously greater than that of a railway wheel and train, and its velocity of rotation immensely quicker, a similar arrest of our globe would give rise to a far intenser heat; so that, as Mayer and Helmholz have calculated, it would not only be melted, but a large portion of it would actually be converted into vapour.

Shooting at a target warms the ball which strikes, and the target which is struck. Motion is arrested, and an equivalent quantity of heat evolved. From this analogy, it struck Mayer, in 1848, that the sun might have the heat which he gives out restored, by the collision of bodies of sufficient size, shot at him with sufficient force; and the same idea has been worked out in this country by Professor William Thompson and others. Bodies are said to give out heat by radiation; that is to say, they excite a motion in the particles of adjacent bodies which tends to raise their temperature. Radiation into space is probably nothing more than exciting this motion in the highly attenuated matter with which it seems to be filled. So long as the Newtonian hypothesis, that radiant heat consisted in the actual emission of particles shot out in all directions from the radiating body, was admitted, the phrase, *giving out heat,* had a distinct and intelligible meaning; but now that this supposition is generally abandoned, we cannot consider radiating bodies as actual losers of any substance called heat, but simply as changing their mode of action as they grow cold. While they are hot they can excite heat in other bodies by a radiating process under which they themselves grow cooler and cooler, unless they experience a counter-action of a similar or different kind by which their heat is restored. Our sun, shining day by day, must, in accordance with this law, grow cold in time, unless his own heat receives continual additions equal to the amount of his loss. It is assumed—perhaps without sufficient warrant—that the sun is hot because he is the cause of heat in other bodies; and it is certain that if his giant orb follows the law that rules the radiation of caloric, he must be constantly losing the capacity of warming, and thus keeping alive, his portion of the universe, unless his heat-giving power is renewed as fast as it disappears, through taking some other form. Very slow would be the so-called dissipation of his heat; all the future generations of man might pass away, our

globe might change and change again in the arrangement of its materials and the nature of its climate, while its fellow wanderers through the realms of space might pass through alterations no less important—there might be time, and ample time, for modifications so vast to take place; but, however remote the final period might be, "The sun himself must die," unless his life experiences constant renovation, as well as suffers continual decay.

That nothing is constant, that all things change, is a sentiment conformable to our reason and experience, and we could raise no argument why in the eternal flux of ages the materials of suns and planets should not be re-arranged. No one can, therefore, feel any obligation to search out causes why the permanence of the universe should consist in anything other than the conservation of all forces of which it is composed. Still, whatever may be the ultimate destiny of the globe which we inhabit, or of the gigantic sun, an infinitesimal portion of whose energy is the source of by far the greater part of the vital and physical work done upon our earth, we can surmise no date for the termination of his labours, nor conceive *when* the period will come in which the system of compensations that we trace on all sides will fail to maintain the stability of our system, and we are, therefore, justified in looking for agencies whose operation will renovate that solar power on which its existence depends. We are only beginning to form some faint conception of the relation which our sun and his dependent worlds may bear to other and remoter celestial bodies. Analogy would lead us to suppose that our system has no independent existence, but forms part of a boundless whole, every portion of which, governed by some ultimate law, is undergoing incessant and harmonious change. There is, therefore, no improbability that our sun should continually receive new matter from realms beyond his own; and if meteoric bodies came within the sphere of his attractive force, and dashed through his atmosphere with velocities so great that the swiftest cannon ball, compared to them, would appear at rest, there can be no doubt an immense evolution of heat must occur. Before, however, we accept this hypothesis of how the sun's heat might be maintained, we must consider all the facts that have to be explained, and what consequences would result from the meteoric bombardment which many are so ready to assume, although there is yet no proof that it takes place.

The attempt to apply the mechanical theory of heat to the restoration of solar power, and the speculations of Kirchhoff, Bunsen, and others, on the constitution of the sun, as rendered more or less probable by spectrum analysis, offer a very wide field, both for reasoning and conjecture; and every student of

science should distinguish between the ascertained facts, or the certain inductions to which they lead, and those daring conceptions which may be the precursors of brilliant discoveries, or which may perish as knowledge advances and certainty is attained.

Whatever may be the fate of ingenious hypotheses, the facts embodied in the mechanical theory of heat will constitute one of the grandest additions to the science of our age. It suggests much new matter to be acquired, but it leaves no doubt of the truth of the magnificent generalizations embodied in such phrases as the "correlation and conservation of force," and we cannot present to our readers a nobler representation of the new philosophy than is contained in the words of Professor Tyndall, who exclaims:—

"The natural philosopher of to-day may dwell amid conceptions which beggar those of Milton. So great and grand are they, that in the contemplation of them a certain force of character is requisite to preserve us from bewilderment. Look at the integral energies of our world—the stored power of our coal fields, our winds and rivers; our fleets, armies and guns. What are they? They are all generated by a portion of the sun's energy, which does not amount to $\frac{1}{2,300,000,000}$ of the whole! This, in fact, is the entire portion of the sun's force intercepted by the earth, and in reality we convert but a small portion of this fraction into mechanical energy. Multiplying all our powers by millions of millions, we do not reach the sun's expenditure. And still, notwithstanding this enormous drain, in the lapse of human history we are unable to detect a diminution of his store. Measured by our largest terrestrial standards, such a reservoir of power is infinite; but it is our privilege to rise above these standards, and to regard the sun himself as a speck in infinite extension—a mere drop in the universal sea. We analyse the space in which he is immersed, and which is the vehicle of his power. We pass to other systems and other suns, each pouring forth energy like our own, but still without infringement of the law, which reveals immutability in the midst of change, which recognizes incessant transference and conversion, but neither find gain nor loss. This law generalizes the aphorism of Solomon, that there is nothing new under the sun, by teaching us to detect everywhere under its infinite variety of appearances, the same primeval force. To nature nothing can be added; from nature nothing can be taken away; the source of her energies is constant, and the utmost man can do in the pursuit of physical truth, or in the application of physical knowledge, is to shift the constituents of the never-varying total, and out of one of them to form another. The law of conservation rigidly excludes both creation and annihilation. Waves may change to ripples, and ripples to waves; magnitude may be substituted for number, and number for magnitude; asteroids may aggregate to suns, suns may revolve themselves into floræ and faunæ, and floræ and faunæ melt in air—the flux of power is eternally the same. It rolls in music

through the ages, and all terrestrial energy, the manifestations of life, as well as the display of phenomena, are but the modulations of its rhythm."

The volume of M. Hirn, and the admirable lectures of Professor Tyndall—which we cannot too strongly commend as one of the ablest efforts to make a difficult subject interesting and intelligible—would supply themes for fifty articles, but we shall only advert to one more topic—the action of vapours in absorbing heat. Mr. Tyndall has contrived an admirable series of experiments, which throw much novel light on the influence which gases, vapours, and the infinitesimal doses of matter diffused by odoriferous substances in the condition of perfume, exert upon heat; but none of his results are more striking than those which refer to the aqueous vapour held in solution in our atmospheric air. Repeated trials made with extreme care show that "the aqueous vapour of air from various localities,* examined in the usual way, exerted an absorption seventy times that of the air in which the vapour was diffused." In other experiments the air of the laboratory at the Royal Institution was dried and purified until its power of absorbing radiant heat fell below unity. It was then led through a U-shaped tube, filled with perfectly clean fragments of glass, moistened with distilled water, from which it absorbed water vapour, and when this vapour was carried into the experimental tube to test its heat-absorbing power, it was found "ninety times greater than that of the air which carried it." The absorptive power of humid air varies with its tension or density, being only sixteen when balanced by five inches of mercury, and as much as ninety-eight at thirty inches, which corresponds with the point marked "Fair" in common barometers. This property of aqueous vapour plays an important part in determining the climate of our globe, and rendering possible its various kinds of animal or vegetable life. "Regarding the earth as a source of heat," says Professor Tyndall, "no doubt at least ten per cent. of its heat is intercepted within ten feet of its surface." Were our atmosphere perfectly dry, the extremes of temperature would be excessive. The sun would burn us during his appearance above our horizon, and when his influence was withdrawn the loss of warmth would be violent and rapid. "The removal for a single summer night of the aqueous vapour from the atmosphere of England would," as Professor Tyndall tells us, "be attended by the destruction of every plant which a freezing temperature could kill," and our earth would soon be approximated to the condition of the moon,

* The localities are mentioned in the original—viz., Hyde Park, Primrose Hill, Hampstead Heath, Epsom Downs, Newport, I. W., St. Katherine's Downs, I. W., and Black Gang Chine.

which—so far as the side we see is concerned—possesses no moisture nor appreciable atmosphere, and is supposed by Sir John Herschel to fluctuate between a boiling temperature and a frost 220 degrees below the zero of Fahrenheit's scale.

Water vapour, as a great absorber of caloric, enables our atmosphere to grow warm, and thus we live in an agreeably diffused heat, while on mountain tops, where the air is very dry, and the solar rays strike with comparatively undiminished force, severe extremes of heat and cold are felt, according as the traveller passes in or out of the shade which rocky masses may afford. The effects of these discoveries of the action of water vapour cannot fail to be considerable upon meteorology, as it offers the true explanation of many phenomenon that have hitherto puzzled investigators. "Imagine," says Professor Tyndall, "a column of saturated air ascending from the equatorial ocean; for a time the vapour entangled in this air is surrounded by air almost fully saturated. Its vapour radiates, but it radiates into vapour, and the vapour into it. To the radiation from any vapour a screen of the same vapour is particularly opaque. Hence for a time the radiation from our ascending column is intercepted, and in great part returned by the surrounding vapour; condensation under such circumstances cannot occur. But the quantity of aqueous vapour in the air diminishes speedily as we ascend; the decrement of tension, as proved by the observations of Hooker, Strachey, and Welsh, is much more speedy than that of the air; and finally our vaporous column finds itself elevated beyond the protecting screen which, during the first portion of its ascent, was spread out above it. It is now in the presence of pure space, and into space it pours its heat without stoppage or requital. To the loss of heat thus endured, the condensation of the vapour and its torrential descent to the earth must certainly in part be ascribed."

Very dry climates will necessarily be more extreme in their changes than those in which the air is moist; and when foreigners from a less humid region, complain of the fluctuations in our weather, we may remind them that however they may pretend to the contrary, they are exposed to more striking vicissitudes. "In Sahara, where the soil is fire and the wind is flame," we are reminded by Professor Tyndal that the cold during the night is often painful to bear; and even in more moderate regions, where the air is dry, the transition is still severe. To our moist skies we owe the delicious green of English landscapes, which is not less beautiful because few artists have enough skill to use it wisely in their paintings, nor because the inhabitants of other countries are preferentially impressed by other hues. To our moist skies we also owe the beautiful com-

plexions of our women, which we should be sorry to exchange for the various gradations of orange, tawny, brown, and black, which so-called better climates produce. Nor must vapour be supposed to have any necessary association with turbid skies. It is when undergoing precipitation that it disturbs the clear deep blue. When in solution it improves the colour of the atmosphere, and leaves distinct the vision of terrestrial objects, or of the moon and stars. Surrounded by vapour from the waters of the Mediterranean, M. Lassell works his great telescope with admirable effect. The air is *dry* because there is heat enough to prevent the precipitation and wetting action of the water vapour, but it is far from dry in the sense of being in a waterless state.

We may regard all bodies as giving out and receiving heat; or, in other words, as receiving and giving an incitement to a particular kind of motion of their particles. "When the sum of motion received is greater than that given out, warming is the consequence; when the sum of motion given out is greater than that received, chilling takes place."* Some bodies allow heat to pass through them readily, others obstruct its course. Some allow it to pass in company with light, others are indifferent to its darkness or luminosity; and the power of acting upon heat is not proportioned to the bulk of the intervening substances, but to their activity or energy. Thus if the absorbing power of air at the ordinary pressure be taken as unity, that of the vapour given off by the perfume patchouli is 30, of lavender 60, and of aniseed 372. "It would be idle," observes the Professor, "to speculate on the quantities of matter implicated in these results. Probably they would have to be multiplied by millions to bring them up to the tension of ordinary air." Thus while on one hand we see heat exerting powers which rend the most solid rocks, and tear the strongest metals, on the other we find its course arrested by a medium so attenuated as a perfume, which a substance could give off for indefinite periods, without sensible loss of weight. What heat may be, in its essence, we know not, nor can we understand why the motions of any particles should yield so wonderful a result. We have no knowledge of matter apart from force, and we recognize heat as one of the great forces of the universe, all of which our philosophy anticipates will be ultimately referable to one force, in which we shall see the eternal supremacy of mind.

* Tyndall, p. 260.

COMETARY PHENOMENA.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

The well-known director of the Observatory of Athens, Herr J. F. Julius Schmidt, has published, in No. 1395 of the *Astronomische Nachrichten*, some curious remarks upon the large comet of last autumn, an abstract of which may be found interesting to many of our readers. The extraordinary clearness of the Athenian sky, which was interrupted by clouds on two or three evenings only between August 9 and September 26, enabled him to obtain such a continuous set of observations as could be equalled, or even approached, in few European observatories; and his results hence possess a special value. The coma he considered more circular and better defined than that of any comet which he had previously observed, and he illustrates the contrast of its outline with that of the narrow base of the tail at its origin, by comparing it to the form of an onion. The light of the nucleus varied greatly in intensity; on two occasions the change on successive evenings amounting to no less than 4 star-magnitudes; a difference, as he says, quite beyond the limits of error with a practised observer, especially intent upon such researches for years; and the observations of twenty nights led him to infer a periodical variation in about 2·7 days; but with rather a large proportion of uncertainty, averaging more than 0·25 of a day. The general *minimum* of light occurred a little after the perihelion; with the *maximum* intensity was connected either the narrowest form of the luminous jet or fan, or in its stead the bright diffused light attending the secondary jet (*mit dem Nebenfächer*); its enfeebled condition was attended by the largest, faintest, and curved form of that appendage. A libration, or apparent swinging, of the luminous jet as compared with the direction of the *radius vector*, or line joining the sun and the comet, was obvious. Without entering into the question whether it may have been one and the same jet, or a succession of them, which was subject to this reciprocation during about 2·7 days, Schmidt found such a period well-marked, with somewhat less uncertainty than that of the variation of light. The angles contained by the position of the jet and the axis of the tail varied from 249°·5 on Aug. 21, to 108°·1 on Sept. 6, with repeated and speedy fluctuations; the extent increasing to the time of the perihelion, and afterwards diminishing. On Sept. 15 a powerful jet was found to have commenced in an opposite direction to the one previously observed; of this he

gives us no further particulars, but he has promised a fuller memoir, with diagrams, which, it may be fairly expected, will prove very valuable. His final results are, for the period of the variation of the nucleus, 2·7 days; for the libration of the jet, 2·74 days; for the return of similar forms of the tail and the jet, 2·82 and 2·99 days respectively; but the two latter quantities have little claim to accuracy. He adds that the rapidity of the emission of luminous particles towards the sun amounted, by an approximate calculation, in the case of Donati's comet, to 371 *toises* in one second; in Comet II., 1861, to 252 *toises*, and in Comet II., 1862, to 230 *toises*, in the same period of time.

A comparison of these remarks with those of M. Chacornac at Paris, in No. 9 of the Intellectual Observer, will be found interesting. The latter astronomer considers it an established fact that a succession of jets were detached from the nucleus in varying directions; inferring that the movement of libration could only have been a deception arising from the spectator's not having watched the progress of the phenomenon with sufficient continuity. The observations of Secchi at Rome are strongly confirmatory of the same view. He speaks of "luminous sheaves (*gerbes*) which were darted out by the nucleus, sometimes in one direction, sometimes in another, the two chief of which pointed, the one towards the sun, the second 45° from the first. These two directions, referred to the line joining the sun and the comet, have been almost constant, which proves two sufficiently fixed foci of eruption in the star. Their direction, however, deviated sensibly from the direction of the sun after the perihelion passage, which constitutes a theoretically interesting circumstance. * * * The most curious fact appears to me to be that of the intermittence of these jets. There has been such a periodicity, that we had at first suspected a rotation of the star around an axis as the means of explaining it, but having followed it during long nights, we have not been able to recognize any progressive variation explicable in this way; on the contrary, we have been present at the extinction and formation of luminous sheaves. Aug. 28, at 8h., the nucleus was without any protuberance, and round like a little planet; at 10h. 45m. it had already a decided prolongation; the nebulosity on the right side had the form of a curved cloud suspended and detached from the nucleus. These facts in their simplicity show that when there are several contemporary centres of eruption, a great number of jets may be simultaneously produced, and become the source of the luminous fans which have so frequently been observed in these stars." All this seems quite satisfactory; still it remains a well-established fact that an actual libration, or swinging

motion, was perceived and followed by Bessel during the last appearance of Halley's Comet in 1835.

The great difficulty which confronts us in every attempt to investigate the nature of these most strange visitants is the absence of all satisfactory analogy. No one could have watched the late opposition of Mars without being convinced of a general similarity between the constitution of that globe and our own; and even in Jupiter and Saturn, though belonging to another planetary type, the evident and complete control of gravity, the provision for day and night, and the existence of an atmosphere of varying transparency and constant mobility, form points of contact, so to speak, of considerable significance. But in the case of comets, with the sole exception of the influence of gravity over the denser portions of the mass, analogy breaks down altogether, and direct observation has hitherto for the most part brought out nothing more than a series of marvellous and unaccountable facts, maintaining obstinately the secret of the law, which no doubt unites them into a harmonious and beautiful whole. We have not as yet any adequate information as to the composition of the nucleus; whether, even in the most brilliant comets, it ever attains a state of actual solidity, or whether all may not be as unsubstantial as one of our own clouds, which at an equal distance and under suitable illumination would no doubt reflect a very vivid light: in fact, as to the real nature of the material of comets, beyond that extraordinary attenuation of mass which makes their attraction imperceptible, even in their closest known appulses to other bodies, we have not a single idea. That they are ponderable is certain, or they would not obey the attraction of the sun; but when we would trace their effect upon the balance of our system, we entirely fail. It appears from the experiments of Secchi upon the late comet with the polariscope, that the light of the nucleus and the brighter part of the "aigrettes" or jets, was never polarized, excepting very feebly on the last day of possible observation, while that of the surrounding nebulosity was strongly so, and the extremities of the jets exhibited an intermediate condition. But even this very interesting result, confirmed to a great extent by that of the great comet of 1861, in which the same observer found the polarization of the light of the tail and the rays near the nucleus very powerful, but no trace of it in the nucleus till July 3 and the following days, when it was strongly indicated, gives no distinct intimation as to the nature of the light. Secchi thinks that the condition of the nucleus may have resembled that of terrestrial clouds, which have no polarising effect, while the coma and tail may have been in a gaseous state; but it is obvious on how slight a foundation such a conjecture as to a

totally unknown material is raised: and though this great and justly-celebrated observer says that if we continue to make as much progress with future comets as we have done with the last three conspicuous ones, our knowledge of their nature will be speedily complete, one cannot help thinking that "the wish was father to the thought." In fact, there would be no greater difficulty in maintaining the converse proposition, that we shall never obtain any satisfactory idea as to their composition, unless we should get actually involved in their extent. There was, indeed, reason to suppose that the edge of the tail swept over us in 1861, but from the imperceptible passage of those very attenuated streams it would be hazardous to infer the results of immediate contact with a glowing nucleus. Up to the present time, the simple question cannot be considered to be decided, whether comets shine by native or reflected light, or by a combination of both; even forms which have been considered to be of constant occurrence, such as the curvature of the tail backwards from the direction of its motion, and the superior density and distinctness of its convex edge, have been shown by the recent comet to be less universal than had been supposed.* Few, indeed, are the points which we can consider adequately established. From the fixity, or limited movement of the jets issuing from it, it may be considered certain that the nucleus does not revolve;† a rotatory motion of the whole tail round its axis has indeed been suspected, from the reciprocating form of its branches in 1769, 1811, and 1825, and thought not impossible by Secchi in 1860: but even should this be admitted in some instances, in others it would be quite incompatible with observation.

It is evident that the whole mass is vehemently acted upon by some influence emanating from the sun, the continuation and accumulation of which, after the perihelion passage, seems to point to a calorific rather than a more instantaneous electric or magnetic action; and it would appear as though the nucleus, even if translucent to light, and reflecting it alike, as Sir J. Herschel suggests, from its interior part and from its surface, and therefore having no shadow or dark side, were not equally permeable by that solar influence, whatever it may be, since the

* The great comet of 1861 might also have been cited; but the direction of its perspective presentation to the eye rendered some of the results precarious and uncertain. The main tail of "the Donati" was strongly curved, yet a feeble ray which preceded it, like a lance borne in front of a streaming banner, though extremely faint, was sensibly straight, and this had been anticipated by similar phenomena in 1807.

† Secchi seems to have entertained an opposite opinion in 1861:—"L'examen de la direction des jets de lumière de la tête nous prouve que la tête avait un mouvement lent de rotation." But, as we have seen, he was unable to establish this, from similar appearances, in 1862.

formation of fans and envelopes takes place only on the side exposed to the sun, while the averse side is comparatively undisturbed, and as it were in a sheltered state. An intermittent or discontinuous process of development is frequently conspicuous, even when no regular period can be established; this was made very evident in succession of envelopes raised from the nucleus of Donati's comet, as described by several observers, and more especially by Bond in his admirable monograph; it was again manifest in the marvellous alternations of brightness exhibited by Comet III. 1860; and, as we have seen, reappeared strikingly in the aspect of our recent visitant. As remote as most of these phenomena are from all our terrestrial analogies, a still wider deviation is to be found in the tendency of cometary matter to repulsion, expansion, and ultimate dispersion. In the formation of the jets and envelopes, in the emission of the tail, in its irreclaimable projection to uncontrolled distances, and in the actual disruption of the main mass —to which there seemed a slight tendency in "the Donati," more in III. 1860, still more in I. 1860, and of which Biela's comet in 1846 appeared to offer a perfect example—we see indications of a process very foreign to our own experience, but remarkably characteristic of cometary matter. This brief and imperfect enumeration of some of the points, which we may look upon as "vantage ground" in such inquiries—in connection with the valuable remarks in the Hon. Mrs. Ward's paper in No. 9 of the INTELLECTUAL OBSERVER—may be useful in assisting amateurs to prepare for the next opportunity of further research, which, though it may be expected to confirm some of these deductions, may probably at the same time surprise us with unforeseen anomalies; for it is an interesting fact that as there is a broad family likeness, so to speak, among the whole class, so each individual (of any considerable magnitude) is apt to be distinguished by such peculiarities as infer most curious variations in composition; even in the same individual, diversities of colour, or want of symmetry in form, give rise to the idea of a combination of various materials, all, to us, equally unknown. What can more strongly impress upon our minds the extent of our own ignorance, or the vastness and complexity of the work of the great Creator!

TRANSITS OF JUPITER'S SATELLITES.

June 2nd. III. enters the disc at 10h. 37m. 5th. The shadow of I. enters at 10h. 9m., the satellite being on the disc; the egress of the latter is at 11h. 19m., of the shadow at 12h. 22m. 12th. I. enters at 10h. 56m., its shadow at 12h. 4m. 13th. The shadow of II. goes off at 11h. 31m. 20th. II. leaves the disc at 11h. 40m., 3m. after the entrance of its

shadow—so great is the obliquity now resulting from the position of the planet relatively to the Sun. 21st. I. passes off at 9h. 29m., its shadow not till 10h. 41m. 28th. The shadow of I. enters at 10h. 24m.

OCCULTATIONS.

June 3rd. ξ^1 Sagittarii, 6 mag., from 11h. 40m. till 12h. 46m. at Greenwich. 5th. 8 Aquarii, 6 mag., from 12h. 46m. till 13h. 54m.

THE NEW $\frac{1}{20}$TH MICROSCOPE OBJECTIVE.

In our brief notice of the *soirée* given by the Microscopic Society we mentioned the fact that Messrs. Smith, Beck, and Beck had exhibited a new $\frac{1}{20}$-inch objective, which appeared to be good; but the circumstances under which it was shown precluded our forming an accurate idea of its merits. Since then we have had one in our possession, and given it many trials, which enable us to speak of it in terms of the highest praise.

We have not enough respect for the recondite markings of troublesome diatoms to esteem very highly a glass which will show them, but do no more serviceable work. Our idea of a high power objective is that it should be equal not only to extraordinary emergencies, but take its place amongst the everyday working machinery which the microscopist naturalist is obliged to employ. Large angles of aperture will enable glasses to exhibit surface markings on diatoms, without their possessing a very high degree of excellence in other respects, and such instruments fail when applied to most of the inquiries by which science is really advanced. There is a due proportion between angular aperture and focal distance, which no doubt admits of theoretical demonstration, and which is approximately discovered in practical work. We do not know that the formulæ have ever been accurately computed, but it is certain that optical skill has made objectives in which the angular aperture has been largely in excess of penetrating power. To our apprehension no glass deserves real commendation unless it possesses all the characteristics which the rational use of a microscope requires. The angle of aperture should be duly proportioned to the focal distance, and the penetrating power should not be sacrificed to any other consideration. This penetrating power, without which no glass can be of general use, depends upon the perfection of the corrections for spherical and chromatic aberration, and upon the due propor-

tioning of angular aperture to focal length. It may, indeed, be possessed by glasses of small angular apertures, but they are then deficient in light, and do not show surface markings as perfectly as ordinary requirements demand. Our skilful opticians have long since produced low powers which answer all the purposes for which they were designed, but it remained for them to devise very high powers free from the practical objections that were inseparable from all the older forms. Great success was achieved by Messrs. Powell and Lealand with their $\frac{1}{25}$th, and now Messrs. Smith, Beck, and Beck have come into the field with a glass that leaves nothing to be desired either for facility of manipulation, abundance of light, or completeness of correction.

When we received their new $\frac{1}{20}$ th we took it out of its case with the expectation of finding a fine piece of optical workmanship, but anticipating a fastidiousness in its requirements that would limit its use. We first tried it upon a Podura scale, which is a more difficult test of accurate correction than any diatom. With the first, second, and third eye-piece of Messrs. Smith and Beck's series — giving powers of 1000 to 3000 linear—we obtained admirable definition with surprisingly little trouble. Then we tried it on the *Pleurosigma angulatum*, and were much gratified with the clear sharp rendering of its delicate markings, and the absence of colour or cloudiness at the edges of the valves. These trials left no doubt that the glass was a very fine one, but we still demanded *more*, and decided not to say over much in its favour, unless it would do good service with the rougher work which natural history or physiological pursuits require. We may seem exacting, but we demanded, first, that the new objective should work through a covering glass sufficiently thick to bear tolerably rough handling, and give any object a good squeeze without risk of fracture; and we further asked that the penetrating power of the glass should be sufficient that the slight inequalities inseparable from living specimens, or hastily prepared objects, should not be a bar to its use. To test the new $\frac{1}{20}$th in these particulars we took a little piece of growing vegetation out of a marine aquarium, placed it on a slide, and covered it over with a glass square, seven-eighths of an inch each way, and much thicker than those used for delicate diatom slides. To our delight the new objective worked admirably under these conditions, and with a very moderate allowance of light, for it was half-past six o'clock on a rainy day, and no artificial illumination was employed. Our capture from the aquarium comprehended a variety of matters. Here was a tangled mass of the exquisite *spirulina;* there, single threads of the same beautiful plant, looking like small cables, and waving about with the singular

motion that gives so much interest to its tribe, and in one spot were five of the same delicate filaments united in a living plait. In this place was that busy rotifer, the *monura,* working his curious pick-axe, and exhibiting his internal organization in the most admirable way; in that place an *anguillula* writhed and twisted like a little *boa constrictor,* with his annulate structure strikingly defined, and his intestinal machinery exquisitely displayed. The scene was wonderful, and the glass used with the facility of a low power. This, we confess, astonished and delighted us. We saw that working naturalists could be supplied with a valuable instrument of research, which would advance their every-day labours, and not be reserved for some extraordinary specialty that would seldom occur. For rotifers, infusoria, desmids, and diatoms, the new glass possesses great advantages, and when we tried it upon the cell rotation in the anacharis, the delicate ripples of the proto-plasmic currents were readily displayed.

The construction of the new $\frac{1}{20}$th, although not copied from it, may be said to follow the plan introduced into this country by Mr. Wenham, namely, the employment of a single lens in front. This plan, which appears to us to resemble that long used in the telescopes, is called *dialytes.* It admits of large angle of aperture, perfect correction, flatness of field, and the capacity for working through glass twice as thick as the $\frac{1}{12}$th or $\frac{1}{16}$th required a few years ago. That these advantages will be highly appreciated by the scientific world we cannot doubt, and to Messrs. Smith, Beck, and Beck belongs the great merit of producing on a new pattern a very high objective that can be used with facility, and is free from the disadvantages and limitations to which very much lower powers were recently subject. We should add that the angular aperture of the new glass is 150°.

PROCEEDINGS OF LEARNED SOCIETIES.

BY W. B. TEGETMEIER.

GEOLOGICAL SOCIETY OF LONDON.

On Recent Changes in the Delta of the Ganges. By James Fergusson, Esq.—The author first explained the laws that govern the oscillations in rivers, either laterally or in the direction of their course; secondly, the causes operating to raise the banks, when flowing through flat plains, above the level of the country; and lastly, the immense relative thickness of the early deposits in deltas

over those of later periods, when the conditions of the river had come more nearly *in æquilibrium*. Mr. Fergusson then proceeded to point out that in historical times the Brahmapootra and Ganges, on entering the plains of Bengal—passing Goalparah and Rajmahal respectively—ran originally to the sea in a nearly due north and south course, parallel to one another. This symmetry was first disturbed by the upheaval of the Modopore jungle, north of Dacca, by which the Brahmapootra was diverted in a south-eastern direction into the depression known as the Sylhet Jheels, which were the result of the upheaval just described. He then further explained how the river, having filled up these Jheels, had returned to its former bed within the limits of the present century.

The paper then described the effect this change had already produced in reopening the rivers of the western half of the Delta, and showed that, if it were maintained, it would have the effect of so raising the eastern half as to restore the course of the two great rivers very nearly to the position they occupied before the disturbance above alluded to. The gradual retrocession of all the mouths of the tributaries of the Ganges, in consequence of the tilting back of the plain, by the gradual rise of the Deltaic plains, was adverted to.

Mr. Fergusson stated that he conceived we had sufficient historical indications to show that within the last 5000 years the plain of Bengal has been nearly in the same condition that the valley at Assam now is—a jungly swamp, with only a few inhabitable spots here and there on the banks of the larger rivers.

The last phenomenon alluded to was the "Swatch of low ground" in the Bay of Bengal. This was ascribed to the action of the tides, which, being accelerated on either shore of the bay, acquired a rotatory motion at the sand-heads, and, meeting in the centre of the bay, scooped or swept out this depression in the centre, and by this action prevented the growth of the Delta seaward to the extent that would otherwise take place.

On the Origin and Subsequent Alteration of Mica-schist.—Mr. H. C. Sorby read a paper on this subject, in which he stated that when ripples are formed whilst material is being deposited, a structure is generated which is termed "ripple-drift." This structure may frequently be seen in polished sections of clay-slates, and also, in a form modified through metamorphism, in many mica-schists. From a consideration of the facts revealed by an examination of those rocks, the author concluded that mica-schist is of sedimentary origin, metamorphosed after deposition, and sometimes after the production of cleavage and other physical changes, and that the bands of different minerals represent the planes of original deposition.

ROYAL INSTITUTION.—*May* 8.

On the Soils of England.—In his lecture "On the Capabilities of the Soils of England," Professor Voelcker advocated several

views opposed to the general belief of agriculturists. He stated that the fertility of land was not capable of being permanently decreased by bad management, whereas by good management the poorest land may be made to yield large and remunerative crops, as evidenced by the success of Flemish agriculture. Formerly the influence of the mechanical properties of the soil were much over-rated, and at the present time too much influence is ascribed to the chemical properties. When potash or ammonia salts pass through soils the basic portion is retained, the acids passing away in conjunction with the lime of the soil. Soda, which is of less importance to plants, is not retained, whereas potash and ammonia are absorbed both by clay or silicate of alumina, and by hydrated oxide of iron, and retained in spite of repeated washings. The sesquioxides, of which those of Iron ($Fe^2 O^3$) and Aluminium ($Al^2 O^3$) are taken as types, may be regarded as weak acids, retaining the alkalies in the soil. Professor Voelcker mentioned that so far from the soil of England being in the process of exhaustion, that its fertility was being greatly augmented, in good farm practice the restoration being in advance of the exhaustion. As a proof of this he stated that in Norfolk the average produce of wheat was—

In 1773 = 15 bushels per acre.
In 1796 = 28 bushels per acre.
In 1862 = 32 to 36 bushels per acre.

The increase being due to drainage, tillage, and to the growth of improved varieties.

ZOOLOGICAL SOCIETY.—*May* 14.

Mr. Reade on the Habits of the Gorilla.—Mr. W. Reade, who has been travelling for some months in the gorilla country, near the Gaboon, on the western coast of Africa, read a paper on the habits of this animal. He stated that it was so extremely shy that it was most difficult to get sight of, that its mode of progression was on all fours, and that its attacking the hunters by advancing in the erect posture and beating its breast, was entirely imaginative. When wounded the gorilla will attack the hunters in self-defence, Mr. Reade meeting one man whose wrist had been injured by a gorilla that bit him, and then escaped. Mr. Reade secured the services of the hunters employed by M. Du Chaillu, and they asked him if he wished to buy gorilla skins, as M. Du Chaillu did. They stated that during their recollection no man had ever been killed by a gorilla, and that the ordinary leopard was a much more dangerous animal to its pursuers. The hunters spoke in great terms of affection respecting M. Du Chaillu, but they asserted that he never shot a gorilla. Mr. Reade stated that the animal when captured young was capable of being tamed, and became very docile.

NOTES AND MEMORANDA.

Inoculation for Pleuropneumonia.—M. C. Lenglen describes to the French Academy the success of inoculation as a preservative against the above disease. In the first place he obtained the virus from the lung of an ox that was affected; but subsequently he obtained the matter in a milder form from the tails of the inoculated animals, portions of which became diseased, and were cut off by the operator. At the time of writing his paper he was employing virus which had passed through twenty-five individuals.

The Sleep of Chloroform and Coma.—M. Flourens contrasts the sleep produced by chloroform with the coma that results from the inflammation called *meningitis*. In coma he says an animal does not sleep; it has its eyes habitually closed, but opens them on the slightest inducement. In a natural state the pulse of a dog is from 100 to 120 a minute, and respiration from 20 to 30. In coma its pulsations are only from 80 to 90, and its respirations 24. Chloroform produces real sleep, with suspension of sensibility; the pulsations (of a dog) are 60, and the respirations 16. After the death of an animal from coma, the brain is covered with red spots, and its vessels congested with blood. An animal killed by prolonged use of chloroform does not exhibit these red spots, only the vessels of the *dura mater*, and particularly those of the cranium, are injected. Thus in the first case congestion is *intra* cerebral, and *extra* cerebral in the last.—*Comptes Rendus.*

Sun Spots and Auroras.—*Comptes Rendus* contains a letter from M. R. Wolf to M. Eliede Remmont, in which the former says, "I find, in accordance with M. Fritz, that the frequency of solar spots corresponds exactly with that of auroras, so that we observe in the latter both the period of $11\frac{1}{9}$ years and the great period of 56 years, the existence of which I have demonstrated for solar spots."

Squaring the Circle.—M. Robinet presented to the French Academy a series of equations laboriously worked out and represented as having a remarkable approximation to accuracy. The proportion of various multiples and fractions of the diameter to the circumference is given, and it is stated that "the side of a square equivalent to a circle of a diameter equal to unity $= \frac{148}{167} - 0{,}000{,}0006 = 0{,}8862269$."

Causes of Fermentation and Putrefaction.—M. Pasteur, many of whose researches will be found in our former numbers, has communicated to the French Academy the results of researches into the action attributed to the atmosphere of oxydizing, and thus consuming dead organic matter, a process which he finds to depend upon the growth of infusoria. He says, "Dead matter which ferments or putrefies does not then yield, solely at least, to forces purely physical or chemical. We must banish from science those preconceived views which consisted in the supposition that a whole class of organic substances—the nitrogenous—could acquire, by the hypothetical influence of direct oxydation, an occult force characterized by an internal movement, ready to communicate itself to organic substances pretended to be slightly stable." He then cites various experiments, and observes that "the slow combustion of organic matter after death, though real, is scarcely perceptible if the air is deprived of the germs of the lower organisms. It becomes rapid if the organic matter is permitted to cover itself with moulds, mildews, bacteriums, and monads. . . . The intermediate principles of organized beings would be, in some sort, indestructible, if we were able to suppress altogether those beings which God has made so extremely small, so useless in appearance, and life would become impossible, because the return to the atmosphere and to the mineral kingdom of that which had ceased to live would be entirely suspended."

Secchi on the Companions of Sirius.—M. Secchi, taking advantage of some fine weather in February, states that he succeeded in seeing the satellite of Sirius, but its distance was a little doubtful, probably 7·5″, angle of position 89°*.

* The diagram given by Mr. Webb in vol. i., p. 147, explains what is meant by angle of position.

With reference to the other luminous points he asks, "Are they realities or illusions?" One he noticed at 5″ distance, and about 180° angle of position. He says he mentions these observations to show the goodness of the telescope; but M. Goldschmidt's observations show that a much smaller instrument will suffice when the air is favourable.

Dr. Wallich on Pleurosigma Markings.—Dr. Wallich resumes this subject in the *Annals of Natural History*, with additional evidence of the correctness of his views. Operating upon a large *P. formosum*, he finds "the lozenge-shaped character of the interspaces unmistakably determined," and also the angulated structure of the elevations. We have seen one of Dr. Wallich's specimens under a $\frac{1}{12}$th objective shown so plainly as to leave little room for doubt. With a smaller specimen of *P. formosum*, and a $\frac{1}{5}$th with a high eye-piece, we have obtained a similar result. All species, however, may not have the same formation.

Dissociation of Carbonic Acid.—M. St. Claire Deville, whose experiments on the dissociation of water were explained in our April No., has in like manner resolved carbonic acid into an explosive mixture of oxygen and carbonic oxyde, in which some nitrogen was present. The temperature at which the dissociation was effected was about 1300° C. The presence of the nitrogen was of course accidental.

Formation of Hail.—M. Sanna-Solaro contests the idea that hailstones are formed by successive concretions. On the contrary, he affirms the congelation to begin from without, and the so-called nucleus to be the result of pressure. He says that when the external surface begins to freeze, the air-bubbles are driven towards the centre, and give rise to a pressure under which the crust yields. "The shock determines the congelation of a fresh layer, which is formed of two distinct parts, one deprived of air and transparent, the other opaque, in consequence of its included air-bubbles." This phenomenon is reproduced at each successive congelation, and if the hailstones reach the ground before the congelation is complete, their central portion may contain bubbles of air, water, and crystals of ice. Pyramidal stones he ascribes to the action of violent congelation, which causes the contained fluid to split the crust. He states that he has imitated hailstones by freezing water in transparent envelopes of caoutchouc. He likewise adduces reasons to show that hailstones are formed instantaneously. Further details will be found in *Comptes Rendus*, 27th April, 1863.

Island in Mars.—Mr. Nasmyth has discovered a little island in a supposed sea in Mars.

Gamma Libræ, a Double Star.—M. Goldschmidt finds a small companion about 20″ distant, and with an angle of position 153°. There is another and larger star more to the south of Gamma, 79″ distant, angle of position, 173°. He says the little star is easily seen by hiding the large one, and he thinks the two will be found members of a binary system.

The Fossil Human Jaw.—M. Quatrefages adheres strongly to the authenticity of a human jaw, alleged by certain workmen to have been taken from a deposit of black sand of an argillaceous and ferruginous character, resting upon the chalk near Abbeville, and covered by four superincumbent strata. The fact of a handsome reward having been offered for human remains, and certain appearances in the jaw itself, have induced strong doubts as to the genuineness of this fossil. If, however, it should be accepted, it would show that the pre-historic race to which it belonged were members of the orthognathous, or perpendicular-faced type, and not of the prognathous, or "snouty" variety of man. The dispute concerning this jaw does not affect any material point concerning the antiquity of man, and no geologist doubts that human remains will be found sooner or later in the Abbeville beds.

The Source of the Nile.—Sir Roderick Murchison has received a letter with the gratifying intelligence that Consul Petherick is not dead, as was reported, but has succeeded in joining Captains Speke and Grant. Captain Speke announces the great lake, Victoria Nyanza, as the main source of the Nile.

MICRO-LEPIDOPTERA,

(Leaf-Miners.)

1.—Cemiostoma scitella. *Hawthorn and Pear.*
2.—Cemiostoma laburnella. *Laburnum.*
3.—Nepticula aurella. *Blackberry.*
4.—Nepticula trimaculella. *Poplar.*
5.—Nepticula Subbimaculella. *Oak.*
6.—Nepticula Anomalella *Rose-leaf.*
7.—Lithocolletis stettinensis. *Alder.*
8.—Tischeria marginea. *Bramble.*
9.—Glyphipteryx equitella. *Stonecrop.*
10.—Elachista luticomella. *Dactylis glomerata.*
11.—Ochsenheimeria. *Dactylis glomerata.*
12.—Gelechia Malvella. *Hollyhock*
13.—Cerostoma Xylostella. *Honeysuckle.*
14.—Gelechia Hermannella. *Chenopodium.*
15.—Head of Ochsenheimeria.
16.—Coriscium. *Oak.*

All these figures are highly magnified. *The natural size is given in the lines beneath each, or in a minute figure.*

17.—Examples of different larva mines. *a*, mine of Nepticula aurella on the *Bramble*. *b*, mine of the Nepticula anomalella on the *Rose-leaves*. *c*, mine of Nepticula viscerella on the *Elm*. *d*, mine of Nepticula marginicolella on the *Elm*.

THE INTELLECTUAL OBSERVER.

JULY, 1863.

THE MICRO-LEPIDOPTERA.

BY L. LANE CLARKE.

(*With a Coloured Plate.*)

Whence come the pretty moths that are figured in this opposite page, of beautiful hues and metallic lustre; the natural size indicated by a mere dot outside the magnified representation? They are glorious as the Admiral and Peacock butterflies in the variety and richness of their plumage, whilst in their instincts they are as wonderful as any of their larger brethren. Few are the observers of the little beings from which these microscopic moths develope. Those who have applied themselves to the study of these minute Lepidoptera have recorded their labours in volumes almost unattainable to ordinary lovers of natural history.* Seven of the ten promised volumes on the Micro-Lepidoptera, by Stainton and Zeller, have appeared; but it is much to be desired that a cheap manual of these interesting little creatures may soon be at hand for our guidance through the woods and along the hedge-rows, as we ramble on a summer's evening.

It was one of the wonders of my childhood what the hieroglyphics upon primrose, bramble, and rose leaves could possibly mean. I saw a white winding stream meandering along with a dark wavy line in the centre, beginning at a mere speck and swelling into a broad river, then suddenly ending. Holding a rose-leaf to the light, one day, there was life within that winding way, a sheltered, naked little worm sustained in the narrow channel between the upper and lower cuticle of the leaf; food, safety, warmth, all provided within the limits of the rose-leaf mine. Picking open the upper skin and finding a small green caterpillar, curious to know its metamorphosis, and failing to preserve the larvæ in the gathered leaves, I bethought me of muslin bags, which I tied over the twigs of rose-trees and

* *Natural History of the Tineina.* By H. T. Stainton and Zeller and Douglas.

brambles, laburnums and lilacs, which were the first mined and rolled leaves I had observed; and great was my joy when from these pages of nature's own book I first learnt the mysteries of the microscopic moths.

Every folded leaf is in truth the habitation of the larva of a minute Lepidoptera, and beneath the leaf a blotch, a pucker, or a tiny tent will, if watched, produce one of these beautiful objects. Scientifically they are divided into leaf-miners, leaf-rollers, tent-makers, and burrowers in the stems of the plant whereon they feed. Not *all* leaf-miners produce Lepidoptera, for several of the Diptera begin life in the same way. The primrose, whose leaves are often covered with irregular, fantastic markings, feeds the larvæ of a small, striped, greyish black fly with yellow legs (*Phytomyza primula*). The thistle is mined by a yellow and black fly (*Phytomyza sonchi*). The turnip and pea by the little yellow *Drasophila*. The plantain, ranunculus, stellaria, lychnis, chenopodium, and silene, are all mined by *Phytomyzides*. The iris, verbascum, euphorbia, by *Agromyzides*, very minute black or black and yellow flies, some of them with bright red eyes, but so small as to be really microscopic; not one line in expansion, yet sad devastators in the garden are they.

But the larvæ of a Diptera may always be recognized from that of the Lepidoptera, at least under the microscope, by the absence of feet in the dipterous larva, and the presence, however minute or rudimentary, of these organs of locomotion in the lepidopterous larva. Sometimes, it is true, the undeveloped condition of the true legs, and the absence in all leaf-miners of the coronet of hooks upon the pro-legs, or membranous feet, on the hinder segments of the body, may create a doubt, as it did in the mind of the great naturalist De Geer, when on finding the rose leaf-miner and examining the larvæ, he thus writes:—

"After examining their figure and the conformation of some of their parts, one would only take them to be *vers* or dipterous larvæ, because they have eighteen legs, all membranous and alike in form, exactly like the legs of *Fausses-chenilles*, or larvæ of saw-flies; that is to say, without the coronet of hooks which distinguish the true caterpillars.

"I thought therefore at first that these were a new species of dipterous larvæ. Sometimes I was inclined to consider them the larvæ of saw-flies, but as they had no horny legs, it seemed to me that they could not belong to these insects. In fact, I persisted in the opinion that my leaf-miners were dipterous larvæ, till they assumed their last form—till they showed me that they changed into true moths."

It was of the rose leaf-miner (*Nepticula anomella*, Fig. 6) that De Geer wrote thus, and it renders the species particularly

interesting when we know that it was the first of the miners which attracted his particular attention, and subsequently led our own naturalists, Westwood and Stainton, to the study of the Micro-Lepidoptera. The little moth itself is frequently found on our windows in the early spring, the dark grey or bronzy wings tipped with violet, and silvery grey under-wings, deeply fringed with delicate cilia. All these microscopic moths are remarkable for the extraordinary size of their scales, and many of them for the rich metallic lustre, iridescent as the scales of a diamond beetle.

To assist the young student in present research, we will notice and describe the species figured of our commonest leaf-*miners*, leaving the leaf-rollers and tent-makers for a future paper.

(Fig. 1.) *Cemiostoma scitella.*—To those who live in or near London there will be no difficulty in watching the development and securing specimens of this lovely microscopic moth, for the larva is abundant in July and August, disfiguring the leaves of hawthorn, apple, and pear with irregular flat brown blotches, and if we hold one of the leaves to the light, the little miner may be seen feeding busily. Also upon a still evening, or on the sheltered side of a hedge, we find in the month of June numbers of small grey moths creeping slowly about the leaves depositing eggs. Their minute size renders the exceeding beauty of their wings indiscernible to the naked eye, and difficult is it to mount them without ruffling the delicate plumage. This is just one of those surprises which an observant mind obtains, when in a mere dot of life such elaborate finish and perfection is discovered. A little creeping ashen-grey moth spreads a pair of upper wings clothed with feathery scales, that require the utmost power of human skill in microscopic lenses to investigate. On the membrane of this wing, which has a definite tracery of veins marking the species, there are rows of cup-like sockets into which each tiny scale is fitted securely for the insect's flight, but will not bear the coarse touch of human fingers. These scales, invisible to us, are composed of three distinct laminæ, two external and coloured, the inner one, a highly polished colourless membrane, which reflects the light and increases the brilliancy of each scale. The wing of this little *Cemiostoma,* shining with the silvery grey mass of microscopic feathers, has a large black spot with violet eye, and streaks of purest white, and deepest black, radiating off into the long silken fringe that is so remarkably beautiful in all these moths. We had not dreamt of such an object for our binocular.

The development of *C. scitella* is as follows: The egg, strangely large for the size of its mother, is laid on the under-

side of a leaf, and the larva, as soon as hatched, bores through the cuticle, and eats away a cavern in the parenchyma, which daily spreads into a large blotch, brown at first but afterwards white, with markings of black in half circles. This is the excrement of the worm as it works from side to side. When full fed, it comes out at the upper side of the leaf, and spins a pretty white cocoon, leaving a slit at one end through which it ejects the cast-off skin when assuming the pupa state, and by which the little moth eventually comes forth.

(Fig. 2.) *Cemiostoma laburnella.*—Lamenting over the disfigurement of our laburnums, every leaf blurred and blotched by the larva of this species, we shall forgive the little depredator when gazing on the beauty of the delicate white moth, and with a half-inch object-glass look down upon the violet pupil on its wings.

Mount this species on a blue disk, for then the radiating fuscous streaks in the cilia will be more distinctly seen.

There is another moth, *Cemiostoma spartifolia,* which mines the *twig,* not the leaf, of the common broom, so like the *Laburnella* that only a practised eye could discern the slightest difference, and yet there is invariably one little variation marking its individuality.

The wing of *C. laburnella* has three *parallel* lines from the second yellow dot through the cilia. The wing of *C. Spartifolia* has three *converging* strokes from the same dot.

Two broods in the year help each other to spoil our laburnum leaves in appearance, not in reality; for although the little insect feeds upon the pulp of the leaf, the veins or channels of the sap are uninjured, and the tree itself does not suffer in vitality. The first brood of *Cemiostoma* comes forth from the mine in July to spin cocoons, and fastens them to branches of the tree; but the second brood in October descend by little silken ropes, and hide themselves amongst dead leaves, spinning a pure white cocoon, firm and warm, wherein to sleep securely through the long winter.

(Fig. 3.) *Nepticula aurella.*—The *Nepticulæ* are the most minute of all the Micro-Lepidoptera, and the most easily observed, as they mine our familiar rose-leaves and brambles, but are not by any means easy to catch, for unlike the quiet and rather sleepy *Cemiostoma,* the *Nepticula* runs with wonderful rapidity, and though they may be found at rest on palings or trunks of trees, yet they are wary, flit off at our approach, and the delicate wings will hardly bear the sweep of a net; it is better to breed them by collecting the cocoons, or enclosing a bramble branch in a muslin bag. The cocoons of *Nepticulæ* are always found in groups of about twenty, though the larvæ are quite solitary in their spinning and feeding.

At any time in July, if we observe the bramble-leaves, we shall find many of them mined by the little *Aurella*—a wavy line running from a minute spot near the edge of the leaf along the border, then doubling back and widening to the end. Open this, and we find a small larva of fine golden colour, with a brown head, and a body so transparent that the circulation may be seen, and the peristaltic movement of the digestive organs. Turn it on its side and we see too many legs for a true caterpillar, which has always six short-jointed scaly legs in front, and from four to ten false membranous legs, armed with a coronet of little bent hooks; whereas *Leaf-miners* have eighteen legs, all membranous and undeveloped, without hooks on any of them, nor are they placed in caterpillar fashion on the body, a circumstance worthy of attention. The first segment of the body has no legs at all; then follow nine pair consecutively, leaving the eleventh and twelfth segments without any appendages.

The head we observe has two flat slender mandibles, projecting considerably in front, adapted for the insect's habit of feeding on the parenchyma of the leaf, without injuring the veins of the leaf or the cuticle. We can watch the action of these mandibles by holding up a leaf to the light, and using a pocket lens. Right and left the little creature wags its head, tears out the soft green pulp, which it swallows, and, widening the channel as it grows, breathes doubtless through the open windows of the uncovered stomata.

When the larva of *Nepticula* is full fed it quits the mine, and walks about seeking a convenient place for transformation. They will spin cocoons quite readily in the corner of a pill-box, and may be collected in October, when they sleep till the following June; but if taken in July, they will emerge as the golden-striped *Aurella* in about three weeks, forming a double brood every summer.

(Fig. 4.) *Nepticula trimaculella.*—Common in all parts of England is this pretty spotted moth, about May and June resting on the trunks of oak-trees. The larva, which is green and shining, with a reddish head, and red dorsal vessel, pulsating visibly under the microscope, mines oak-leaves in a blotch about an inch long, close to the mid-rib, from which it issues to spin a pale, yellow, mussel-shaped cocoon. The *Neptículæ* always mine the *upper* side of leaves, except this species, which is sometimes found on the *under* side.

(Fig. 5.) *Nepticula sub-bimaculella.*—Another little oak-miner, but not double-brooded, and so only found in October in the larva state, making a triangular blotch in an angle between the mid-rib and one of the veins. The egg has been laid on the *upper* side of the leaf close to the mid-rib, and the

larva has kept very close to the rib, leaving a thick, black, central line of excrement; after which it turns about and eats out a blotch, in which, as it grows, the excrement is deposited in grains. From these observations it appears that the excrement is always fluid in the early stage of larva life, and becomes solid as the digestive organs develope.

(Fig. 6.) *Nepticula anomalella.*—This little moth has been already noticed as the subject of De Geer's observations. We can readily find specimens upon our rose-trees in July and October, mining in serpentine galleries the *under* side of the leaf, but coming out at the upper side, and spinning a cocoon at the footstalk of a leaf, or under a projecting thorn. There is another leaf-miner on the rose, *N. Anguli-fasciella,* much prettier, having dark wings, and a curved silver band across; and in the larva state they may be distinguished by the *Anomalella* being amber-coloured, and other of a pale green. We often find three or four of these little miners on the same leaf, in which case they cross each other's path, and make the tracing of a single mine rather difficult.

(Fig. 7.) *Lithocolletis stettinensis* (*Argyromiges*).—The family of which this beautiful moth is a member contains seventy species, so delicately small, and yet so brilliant, that naturalists have called them the humming-birds of the Lepidoptera. The larvæ are extremely abundant on the elm, maple, honeysuckle, scabious, oak, and nut trees. The young collector may forthwith (on reading this paper) begin to observe the leaves of these trees and plants, and learn to distinguish between the mine of a *Nepticulæ* and that of a *Lithocolletis.* Some species mine the upper and some the lower cuticle of a leaf. It is found that the larva of a *Lithocolletis never quits its mine,* but changes therein to a pupa; and the empty pupa-skin may be found protruding from a slit in the cuticle after the escape of the perfect insect—which will decide the question in this instance, as the *Nepticulæ* always emerge from the mine, and fix themselves to a stalk or a dead leaf for transformation. There is but one exception, and that is with *Nepticula septembrella,* which mines the leaves of *Hypericum pulchrum* (small upright St. John's wort) in autumn, making extremely slender mines around and across the small leaves; when full fed, they pucker the leaf a little, and form a cocoon inside the mine.

Again, the larva of a *Lithocolletis* more or less contorts the leaf, which *Nepticula* does not, and carpets the loosened cuticle with silk, pulling it so tight that not only does the skin pucker, but the opposite side of the leaf is drawn into a curve.

One more distinguishing mark may be given. The larva of a *Lithocolletis* has only fourteen feet, and the third and fourth segments are considerably enlarged; whereas a *Nepticula* has

eighteen feet, and uniform segments. I have also observed that the summer brood of *Lithocolletis* transform into a brown pupa, but the autumn brood spin a small yellow cocoon within the mine for the preservation of the pupa during the winter months.

The leaf-miners abound in July and October, and the dead leaves of the oak contain the pupa of *L. roboris, hortella,* and *Amyotella* all the winter through, producing very pretty moths. The *L. stettinensis* is found mining the upper side of alder-leaves; but a species extremely like it I have reared from rose-trees, of a deep reddish orange colour, barred with silver, edged with black, *without* the black spot which *stettinensis* has upon the margin of the wing. The elm feeds the beautiful little *L. Schreberella,* bright orange, dotted and barred with silver; the maple gives us abundantly that pure white moth, *L. sylvella,* which has yellow bars bent into angles, and edged with large, jet-black scales. All round London, Oxford, Bristol, Shrewsbury, we fail not to find this little miner blotching the leaves in July and October.

(Fig. 8.) *Tischeria marginea.*—With folded wings, closely pressed to the substance upon which it rests, this pretty moth sits with head slightly raised, and long antennæ thrown forward. We see it in May and August flitting over the brambles. The bright yellow dot of life is absorbed in the work of instinct, depositing its eggs on the under side of the blackberry-leaves, which will soon have the tracery of a little mine, resembling a *cornucopia,* and puckered at the widest part because the *Tischeria* does not quit that shelter, but changes to a pupa in its mine. Side by side we may observe the more wavy and intricate hieroglyphic of the *Nepticula,* and compare the larva; for the miner of *Tischeria* really requires a microscope to distinguish any feet at all. The moth is four lines long, and is first cousin to the *Elachistadæ,* or Grass-miners, of which we have figured—

(Fig. 10.) *Elachista luticomella.*—Until lately these were but little known. Stainton (our best authority) names forty species of the Grass-miners, who, when full-grown, quit the mine, and attach themselves to the stem of a neighbouring plant. They fix their bodies by a silken belt, like the cabbage caterpillar, and change to an angulated pupa. This pretty *E. luticomella* may be seen in swarms on summer evenings, hovering over their favourite *Dactylis glomerata,* and which feeds the young larvæ.

The prettiest specimens to seek are the—

E. Brunnichella, a golden-brown moth, barred and dotted with gold; found in hedges during May and August.

E. Gleichenella, which has brown wings, also spotted and

barred with brightest gold, and found flying over short grass under furze-bushes.

E. chrysoclista, common in St. James's Park in June and July; remarkable for its *metallic tufts* on a deep orange-coloured wing, bordered with black, and with purplish-black under-wings. It has three tufts of black and silver scales on each wing.

(Fig. 11.) *Ochsenheimeria* is properly not a microscopic moth, for it is from five to six lines in expansion, and not particularly beautiful; but the head is most curious, and deserves observation (Fig. 15). Those feathered antennæ and bird-like eyes are unlike all other moths. We can only catch this little grey fellow in the hottest part of the day, from 12 A.M. to 2 P.M., when it hops about the grass, depositing eggs on the *Dactylis glomerata.* It is marvellously quick in hiding away, and if not swept into the net whilst on the wing, will not be easily secured.

(Figs. 12 and 14.) The *Gelechidæ* have varied habits, for the larvæ of many of them feed between the united leaves of sallows, honeysuckle, firs, oaks, and apple trees. One species, *G. mulinella,* luxuriates in the sweet flowers of the broom and the furze in July and August. *G. malvella* (Fig. 12) is a plague to the florist who may especially care for his hollyhocks, and grieve to find his seeds devoured by the larvæ of this moth; but *G. hermanella* (Fig. 14) is a true leaf-miner. We find the larvæ making dirty green blotches on the leaves of *Chenopodium* and *Atriplex,* and the moth, flitting over these plants in July and October, is bright orange red, flaked with silvery streaks, and set off by jet-black scales. These moths are scarcely microscopic, being from *six* to *nine* lines in expansion.

(Fig. 13.) *Cerastoma xylostella.* — Measures ten lines across the out-stretched wings, yet it belongs to the Micro-Lepidoptera, and its larva, bright green, with scarlet stripe along its back, will in July be feeding on the honeysuckle.

(Fig. 9.) *Glyphipteryx equitella.*—Not a leaf-miner, but a *burrower,* and with a truly microscopic beauty, for the exquisite markings of its wings are never well seen except with a pocket lens or a three-inch object-glass. The dark bronzy-grey ground is streaked with pure white, edged with silver; two violet-silvery spots in the middle, and another at the tip, near which a hook of jet-black scales project through the cilia. This moth flies over the stonecrop in June, where it deposits the eggs, from whence a little miner comes forth to plunge into the stem, and work away in a channel through which it revels in the ascending sap. Another extremely pretty species is the dark-green *Thrasonella,* abundant amongst the rushes in June and July; and these are so varied that no two are exactly alike.

The wings of *G. Thrasonella* have streaks of bluish silver more or less distinct, and the large blotch of black lightened by three silvery violet eyes may not be found equally brilliant in all; even the cilia is sometimes more broadly tipped with white, and the bronzed green thereby relieved. The size also varies from *three* to *six* lines across.

Then, upon the pure white clustered blossoms of *Anthriscus*, or Wild-beaked Parsley, we frequently see a dark, small moth resting, and then running to and fro, raising and depressing its lovely wings as if fanning itself. This is *G. Fischeriella*. We know not where its larva feeds, nor is it confined to the *Anthriscus*, though it seems to love *that* flower best. We find it in the garden upon candytuft and other flowers; also swarming round young fir-shoots. Only with a microscope can we rightly see the tinted plumage of the dark velvetty wing, striped with white and silver, and having one rich violet eye in the anal corner.

I have but to notice the head of *Coriscium* (Fig. 16), an oak-leaf miner, plentiful in April, June, August, and September, whose drooping and tufted palpi show us the minute yet decided variations which mark the species, as well as the beautiful-plumed head of *Ochsenheimeria*.

Pondering on the hieroglyphics these little miners trace, words of infinite wisdom to the eye that can read and the heart that can understand; seeing how in darkness yet perfect security the naked worm feeds, grows, and developes a new and wondrous beauty of which it is wholly unconscious, and of which for thousands of years man was profoundly ignorant; we pause reverently before the tracery on a rose-leaf, the blotch on the laburnum, and we look beyond the present mystery of our own life, oftentimes a dark and a winding way, with a hope strengthened in looking at the glorious wings of the hitherto scarcely appreciated Microscopic Moth.

ON FOSSIL OTOLITHS,

AND NOTES ON THE

AUDITORY ORGANS OF THE LOWER ANIMALS.

BY W. W. STODDART, BRISTOL.

The subject under consideration is one of the highest interest both to the geologist and comparative physiologist.

The fossil otoliths of fishes have generally escaped the notice of fossil collectors, which is the more strange, as the author has obtained some hundreds of specimens from some of the British strata. Nor are they described in any work yet published on geology. The nearest approach is in the first volume of the *Geological Journal*, where Professor Owen describes the petro-tympanic bones of four species of fossil Balænidæ from the Suffolk crag.

It indeed appears that very little is said by any author on comparative physiology concerning the auditory organs of recent osseous fishes. This in some measure arises from the universal dissection of *cartilaginous* fishes, whose heads, being more transparent, are easier of manipulation.

A few years ago an esteemed friend of the author's, E. T. Higgins, Esq., well known in the geological world, while examining the marine sand from Hordwell Cliff, found some curious little fossils which had never been figured or described. A careful examination and comparison proved them to be really the "otoliths" or ear-bones of fishes.

In the February number of the *Zoologist* for 1859, Mr. Higgins published a short notice, stating the fact that he had found the ear-bones of many recent genera of fishes in a fossil state. Since that time both he and the author have been carefully examining all the geological strata for these remarkable little fossils. And so successful has been the investigation, that besides several new facts in the anatomy and natural history of fishes, the fossil otoliths of the cod, whiting, whiting pout, power cod, pollack, flying fish, and many of the Pleuronectidæ have been determined.

They have been principally found in the Crag of Suffolk, the Eocene beds of Sussex, Hampshire, and Isle of Wight.

In a very remarkable bed in the Bristol Lias, the author has collected a body that very probably may turn out to be an otolith of the Pholidophorus; but as only one specimen has yet been found, its nature cannot yet be determined with perfect confidence.

In order to ascertain the species of fish to which the several

ear-bones belong, it is necessary to dissect an immense number of heads; for a most striking fact has been demonstrated, and one without analogy in natural history, viz., *that a characteristic form is more peculiar to the species than the genus or family.* That is to say, the ear-bones of a species have invariably a configuration peculiar to itself. But no form has yet been observed that will point out a genus, family, or tribe; for example, the same general form is equally found in the ear-bones of the Clupeidæ and Scombridæ, but still there is no difficulty in determining, with the greatest confidence, the specific name of a mackerel or a herring by the markings on their ear-bones, because they are always constant and never the same in two species.

With all these interesting relations and the frequency of their occurrence, it is very remarkable that the fossil otoliths have not been noticed before. The collection of Mr. Higgins and the author contain more than forty species of fossil otoliths, all distinct, and many of fish hitherto unknown in the fossil state.

Otoliths occur much more abundantly in the tertiary beds than any other parts of fishes, and much more so than the teeth. This fact at first sight may appear startling to the collector from the palæozoic rocks, when the commonest remains are the teeth, spinous defences, and scales. But a little reflection will easily solve the apparent riddle.

In the Silurian, carboniferous, etc., seas, the principal inhabitants were cartilaginous fishes, and the hardest and most indestructible portions of their bodies were the teeth and spines; whereas in the later tertiary beds the osseous fishes predominated, which do not possess the fin-spines or solid crushing teeth. Of them the hardest parts are the ear-bones in question.

That they are really the otoliths of osseous fishes their figure and configuration undoubtedly prove; but the more clearly to explain the position and function of an otolith, it will be better to trace the development of the auditory organ from the lowest organism in which the author has noticed it, to the complete and elaborate ear of the mammifer.

Sound is the vibration of solids and fluids propagated by means of waves through some intervening medium. At least such is the present theory.

Now the office of an ear is to intercept and collect these undulations, and to convey the result to the brain of the individual.

In every auditory organ there are two things absolutely necessary, viz.:—

1st. A fluid wholly or partially filling the internal ear.

2nd. A solid body or bodies of greater specific gravity than

the surrounding substance over which the auditory nerve is expanded.

On reviewing the different forms of ear, we find these conditions always present.

Of course animals that live in two media that have such different densities as air and water, require two distinct adaptations of auditory apparatus, although the same principles are present in each.

A sound that would be melodious and musical to the human ear would be absolutely stunning to that of a fish, simply from water being a better conductor than air.

Abbé Nollet performed many experiments to prove this. While totally immersed in water, he struck together two pieces of stone or metal, when the resulting sound as perceived by the ear was quite unsupportable.

The simplest form of an ear is that found in aquatic animals. It is at the outset merely a cavity filled with fluid, over the surface of which a nerve is expanded. This only receives the vibrations in a very imperfect manner, and is quite incapable of resolving them into tones.

This simple arrangement is by no means the usual one; commonly the sac is *enclosed* and filled with a *gelatinous* fluid (endolymph), which, when the undulations were received, would, on account of its greater specific gravity, more clearly communicate the full force of the sound, through the nerve to the sensorium.

The next step to increase the hearing power is the addition of a solid to this gelatinous fluid, and which, according to well-known acoustic laws, would materially increase the sensibility to vibratory influence.

A still greater advance is the suspension of the whole in a more liquid material (the perilymph).

Almost every seaside visitor will recollect an apparently lifeless mass of jelly that so frequently lies on the beach. Divide it with a knife, and it shows no sensibility. Cut it into a dozen pieces, and it offers no opposition. Lay it out to dry in the sun, and what before was so many pounds is now scarcely as many grains, only a mere film. The most acute observers have as yet failed to prove the presence of a nervous centre. Nevertheless this living wonder possesses ears! and those of a very beautiful construction.

On placing this seemingly inert mass in a little sea-water, it will unfold in the most elegant proportions, and is at once perceived to be the *Rhizostoma pulmo*, or sea-blubber. When a small piece of the edge of the *umbrella* is placed under the microscope with an inch lens, a small notch with a cavity will readily be seen. In the centre of this is a small body suspended

by a ligamentous neck, resembling very closely the clapper of a bell. This is the auditory apparatus, and the small suspended body is in reality an otolith, which rapidly oscillates at the rate of about 100 times a minute. In a small specimen it measured $\frac{43}{1000}$ of an inch in diameter. Many authors state that they have never observed these oscillatory movements, but in this species they may be readily seen.

In the rhizostome the author has failed to detect the little prisms which Mr. Gosse and others have remarked in the auditory capsule of the *Medusa aurita*. Neither graduated pressure with the compressorium, nor the delicate action of polarized light had any effect on their demonstration. When mounted in a deep cell, this little auditory capsule is a very beautiful object for the binocular microscope.

Strange to say, common as the insect class are, and well known their powers of hearing, yet the auditory apparatus has never yet been satisfactorily made out. Ramdohr has placed it in the jaws, Strauss-Durckheim in the antennæ, De Blainville in the sides of the body, and Agassiz in the legs! Most probably they will be found in or near the head; the experiments and preparations of Treviranus and others go far towards the support of this idea.

In the Crustaceans, the auditory organ is easily made out and seen by examining the base of the larger antennæ of a lobster or crawfish. It is a little prominence of very hard shell, having a circular opening at the apex, across which is stretched a thin membrane. Inside this is a sac filled with liquid, and having the auditory nerve distributed over its inner surface. Under the bottom of this sac, in some species, is a small triangular otolith, which is in direct contact with the nerve.

Dr. A. Farre, in a communication to the Royal Society, disputed this, and affirmed the locality of the ear was on the lesser antennæ. His views are, however, untenable. One reason only need be adduced, viz., that the auditory nerve may by careful dissection be traced to the prominence on the greater antennæ before mentioned. This fact is beautifully shown in a dissected specimen of the lobster, by Dr. Brittan, and now in the Bristol Museum.

Siebold was the first to notice the organs of hearing in the next great class of invertebrate animals, the Mollusca. In the Conchifera it is situated in the foot, and consists of a large central ganglion, on each side of which is a minute cavity filled with the usual endolymph, and inclosing a small otolith.

With a half-inch objective this otolith may be conveniently seen in the Cyclas, having a rapid oscillatory motion.

In the Gasteropoda this organ occurs at the base of the

tentacles. In the auditory sac are three otoliths, the shape of which varies according to the species. Here, for the first time, the otolith shows a *groove* for the reception of a suspensory ligament.

In the Dibranchiate Cephalopods the first approach to a labyrinth is seen.

We now come to the second grand division of the animal kingdom, Vertebrata.

In fishes, we find the organs of hearing have a great and important addition, viz., "the labyrinth," consisting of three semicircular canals communicating with a vestibule, which, with two ampullæ formed by an expansion of the semicircular canals, give rise to three cavities at each side of the base of the brain.

In these cavities are contained the organs of hearing, which in all fishes possess the same parts, differing only in specific differences of form and configuration, as would be expected.

In no work on fishes, especially the osseous ones, have these organs been correctly described. Moreover, those descriptions already published seem to have been from cartilaginous fishes.

The examination of an osseous fish is the better one for comparison with the fossil otoliths before mentioned. The best species for the purpose of study are the skate, herring, mackerel, or salmon.

In each of the before-mentioned cavities, that is, the vestibule, with an anterior and posterior ampullæ, is an otolith, so that in the head of every fish there are *invariably six otoliths*.

The central otolith is very much larger than the other two. They are connected together by a tough ligament, which, after enclosing the two smaller outside otoliths, passes under the central one through a groove for that purpose. All are suspended in a gelatinous endolymph and enveloped in a thin membrane something like the white of an egg, or the humour of an eye. Over this membrane are spread exceedingly minute branchlets of the auditory nerve, which traverse and anastomose in every direction, forming an exquisite network, which literally suspends the whole in the limpid perilymph, that completely fills the semicircular canals, vestibule, and ampullæ.

The cartilaginous fishes have the same number of otoliths, but they are not so hard and brittle, from the non-deposition of carbonate of lime.

The otoliths are evidently formed by the semi-crystallization of carbonate of lime in a gelatinous fluid, a condition which is well known to every chemist as interfering with the proper crystalline angles and planes by altering the regular arrangement of the calcareous particles.

For the sake of convenience, and for a slight analogy, here-

after to be mentioned, to the ossicula auditûs of the mammalian ear, the author has given to these three otoliths the provisional names of Malleolus, Incudeolus, and Stapeolus.

The malleolus is the otolith found in the posterior ampulla. It varies very much in size, shape, and position; most usually it is semi-transparent, very thin, and has the interior margin pectinated. Under the microscope it shows exceedingly well the calcareous granules in the course of deposition. It is the most delicate of the three concretions. In some fishes it lies upon and across the end of the neighbouring otolith.

The second and largest otolith is the incudeolus. It is that which is found in the fossil state. Its form is oblong, usually broader at the anterior than at the posterior extremity, and convex on the upper surface. On the convex, or under side, is a peculiarly-shaped groove for the suspensory ligament which connects the three otoliths. The shape of this groove is one of the most important and characteristic marks that are constant to each species.

The incudeolus differs in the Pleuronectidæ altogether in general shape, being truncated at both ends, and having a broad, flat subquadrate figure.

It is this otolith which the author so strongly insists upon as a trustworthy evidence in cases of specific identification. That is to say, so constant is the shape of this otolith to each *species* of fish, that the genus and species of any fish may be determined with the greatest accuracy by a careful inspection alone of this one otolith.

Some families have a slight general configuration which may assist the investigator to the possibility of a species, but nothing short of an absolute identity in the otolithic shape, and most especially that of the ligamental groove, will answer for certain identification of a species. But fortunately so exact and constant are these characters that no difficulty will be found when once the otolith of a fish has been seen. In this, however, arises the labour of identifying a fossil species, because the specific name cannot be determined until a recent specimen of the same species has been dissected.

In the Gadidæ, which comprise some of the most abundant of the fossils, the incudeolus is pyriform, rugose, and thick; this is exemplified by the whiting pout (*Morrhua lusca*).

In the Clupeidæ it is furcate at one extremity, as in the herring (*Clupeus harengus*).

In the Salmonidæ it is furcate at both extremities, as in the salmon (*Salmo salar*).

The stapeolus is the smallest of the otoliths, and is either rounded, subglobular, or furcate. The last-named form closely resembles the stapes, when, as in some animals, it wants the

base of the stirrup. A very remarkable instance is seen in the *Callichthys thoracicus*, or Demerara fish. The stapeolus is always enclosed near the anterior extremity of the otolithic ligament, and frequently firmly imbedded in its substance.

The appearance of the otoliths is very different in appearance from the bones of the fish; they have a porcellanus appearance, and quite distinct from the semi-transparent bones of the cranium.

The otoliths of the fresh-water are much more rounded and globose than those of the marine fishes.

As objects for the binocular microscope, none are more beautiful than these bodies; among them may be recommended those of the sprat, brill, smelt, anchovy, and grey mullet.

For sections those of the Pleuronectidæ may be preferred. It will be at once seen that the above observations do not at all agree with a paper read by Dr. Redfern before the British Association in 1859. In this Dr. Redfern says that "The otoliths of the cod, flounder, salmon, etc., are so similar in structure, that the one from the cod may be taken as the type." The author's specimens are so very dissimilar in every respect, that evidently some confusion must have occurred among the Doctor's specimens. The Pleuronectidæ (flounder) differ as much in their otolithic shape from every other as the salmon does from the cod.

Another of his observations is equally puzzling. He says (abstract Brit. Ass. Rep. 1859)—"The otolith" (for he only speaks of one) "when in position, appears to form one wall of an irregularly rounded cavity, from the interior of which the sonorous vibrations may be reflected, and thus affect the nerves." None of the author's dissections of the osseous fishes of more than 120 individuals support this statement. The central otolith of which Dr. Redfern speaks is freely suspended in the *midst* of the endolymph, and moreover is entirely surrounded by a membranous coat, which in many cases has to be slit open before the otolith can be obtained.

Fishes can do no more than be sensible of a noise. They cannot distinguish modulations or differences of tone.

One is reluctant to destroy a pet idea, however poetical and pretty, yet the searcher into scientific truths is often compelled to do so. It is so in this instance, for truth compels the assertion of the impossibility of the supposed fact that fishes delight in musical sounds, or come to be fed by the attraction of a whistle. The true explanation is, that the vibration of the footstep, not of the whistle, is the source of attraction. This may be proved by a walk along the margin of any canal or pond. Every one must have noticed that a footstep will instantly startle any of the finny tribe that may be lurking

under the grassy margin. On the other hand, if the observer be standing still, he may talk or whistle almost as loud as he likes, without the fish taking the slightest notice, provided he keeps himself and his shadow out of sight.

In reptiles we have creatures that partially or wholly live in the air, and therefore require a more sensitive arrangement for the reception of sound.

We here, for the first time, notice a *tympanic membrane*, but as yet no external orifice; for were the membrane exposed as in the mammal, sounds would be unbearable when in water, as before explained. It is, therefore, entirely covered by the skin.

The position of the ear may be readily seen in the frog, as a circular depression behind, and a little below the eyes. In these animals the otoliths change their character, and partly their office. The stapeolus here elongates into a long, sometimes trumpet-shaped body (columella). The other two otoliths, on the other hand, are much diminished, and are partially embedded in the fibres of the tympanic membrane.

The expanded extremity of the columella forms a kind of disk that closes the foramen ovale.

It is not a little curious that in the higher saurians and ophidians that a rudimentary cochlea may be observed, slightly conical in shape. This addition would most probably account for the impression which music is said to make on the serpent tribe.

The auditory organs of birds do not materially differ from those of the higher reptilia, except that in the former there is an external orifice, though small.

Some of the owl tribe have a rudimentary concha, but more commonly the external orifice is merely surrounded by a few feathers.

It is, however, in mammals that we reach the highest perfection in the construction of the ear. The mammalian ear is a sublime, yet simple, example of adaptation of a means to an end.

The external ear is now added, fitted with a funnel-shaped organ, and possessing a suite of muscles, and every appliance for the reception of the minutest sound. The cochlea, which we saw commencing in the highest reptilia, is now very complex, and enables the mammal to minutely distinguish one tone from another. The tympanic membrane is now fully exposed to the aerial vibration. The columella is now replaced by a series of small bones, which, as in reptiles and birds, connect the tympanic membrane with the internal ear.

The analogy between the otoliths and ossicula auditus has been often denied. It is undoubtedly true that the latter have

functions which the former have not; but at the same time it is equally true that all the offices of the fish otolith are performed by the mammalian ossicula. For besides the function of contracting, or otherwise, the tympanic membrane, they also, by their specific gravity, help to *intensify the vibratory influence,* and thus perform the part of otoliths. This fact it was, coupled with the number of bones or otoliths being nearly always *three,* that induced the author to give to the otolithic concretions their present provisional nomenclature. From the medusa to man so gradual is the transition from the true otolith to the ossicula of the mammal, that every step in the gradation may be found.

The question may now be fairly asked, What is the auditory arrangement of those animals that exist, as it were, in an intermediate state, and which partake of the nature or habits of two classes? It is a strange fact that the ear is still a constant mark of difference. For instance, the ornithorhyncus and kangaroo, which possess somewhat of the attributes of a bird, whilst they are undoubtedly mammals, actually possess the columella of a bird.

A still more remarkable instance is in the Cetacea.

It has already been mentioned that had aquatic animals the ears of aërial ones, they would be stunned by what we should call a slight noise. The whale, then, being a true warm-blood mammal, and at the same time living the life of a fish, how can it hear? The truth is, that the cetacean ear is a very wonderful combination of the ichthyic and mammalian organ. It hears, as it were, backwards, for the Eustachian tube opens into the blowhole, while the external orifice is nearly closed. The petrotympanic bone acts as a true otolith, while the mammalian ossicula and tympanic membrane are also present. When, therefore, the cetacean comes to the surface for air, it hears aërial vibrations through the Eustachian tube, while at the same time the otolithic ear is immersed, and cognizant of aquatic sounds.

The progressive steps have thus been briefly traced up to the beautifully constructed ear of the mammal, from the early condition in the medusa, when we first noticed an otolith, then the semi-circular canals of the fish, then the tympanic cavity of the reptile, and lastly the cochlea and external appendage of the mammal.

If the most profound philosopher had been requested to construct such an organ, what laborious calculations would he have made! what a complex set of mechanical contrivances! what a life-long study of acoustic and mathematical principles! and yet, after all, would undoubtedly have failed in accomplishing his purpose.

If a sceptic were to be watching the needle and scalpel, no investigation would be more conducive to admiration of a good and omnipotent Being, or one that would more convincingly conduct one's thoughts from nature to nature's God, and force the acclamation that—

"The hand that made us was divine."

A NATURALIST'S VISIT TO WALTON HALL.

BY THE REV. J. G. WOOD, M.A., F.L.S.

Having lately enjoyed another opportunity of examining at my leisure the unrivalled collection of preserved animals at Walton Hall, I hasten to draw attention to the marvellous success of the method by which they are mounted—a method so bold, so original, so utterly opposed to all recognized systems, and so apparently impracticable in theory, that actual inspection is needed in order to gain a true appreciation of so triumphant a result.

I take for granted that all readers of the Intellectual Observer are acquainted with Mr. Waterton's *Wanderings*, and his subsequent volumes of essays, so that there will be no necessity for recapitulating facts which are already familiar to the reader. Suffice it to say that many years have now elapsed since Mr. Waterton announced his discovery of a process whereby the natural form of beast, bird, reptile, fish, crustacean, or even insect can be restored as in life, whereby it is made totally impervious to moth, mite, beetle, or any of the voracious tribes which devastate museums, and is inaccessible to "mould" in any form.

These were bold assertions to make, but more were to follow. It was furthermore asserted that specimens preserved in this manner could be cut up, removed piecemeal, and put together again without betraying a sign of their separation, that their weight should be less than that of the newly-flayed skin, and that no wires, woodwork, or internal support of any kind should be employed. I think that a more audacious plan was never originated, for the natural inference of such promise is that the skin shall be its own support, and shall, moreover, be so firm and strong that it will retain its shape even when cut to pieces, and be free from the slightest warping of the structure. It followed, also, that no stuffing is required within the skin, because if any substance had been employed for that purpose, it would have added much to the weight of the preserved specimen, and would have materially interfered

with the cutting-up and putting-together process which has just been mentioned.

Have these promises been fulfilled? Yes, and more than fulfilled. Time and experience, the two great teachers, have shown that to this process belong numberless advantages, and no perceptible disadvantages.

In the first place there is no unpleasant smell from the animals, every particle of it is placed beyond the power of decomposition, and as odourless as if it were carved from stone. No longer need the owner start with horror at the sight of a clothes-moth, a mite, or a dermestes, but with perfect unconcern he permits the creature to go its way, knowing that it has no more power to eat his preserved animals than to feed on the glass-case which protects them from the dust. That, indeed, is the only use of a glass-shade when you have such specimens, and excepting that dust, especially that grimy variety which hovers about the metropolis, is apt to collect on the fur and feather, and in time to dim their pure colouring, there is really no need for a case at all. Several large specimens at Walton Hall are without any protection, and many of the glass-cases are nothing more than five plates of glass fastened together at their edge box-wise, so as to cover the specimen, and protect it from the soiling touch of inquisitive hands.

Again, the specimens are far less obnoxious to injury by violence than if they were stuffed in the ordinary manner. Suppose, for example, that the Museum takes fire, and that the only hope of saving the specimens is to throw them out of window. I think that there would be sad havoc among heads, limbs, and tails of stuffed specimens, whereas the empty skins may be flung to any depth, and be none the worse for the tumble.

Throw a blown bladder from the top of a lofty house, and see what harm it takes; then put a series of wires inside it, together with a piece of wood, stuff it with tow and cotton-wool, and subject it to the same test. It will fall *rather* more rapidly and stop rather more suddenly, than if it were nothing but an empty membrane. Now, that is just the condition to which Mr. Waterton reduces his specimens, with this distinction, that when they are wounded they do not collapse. Indeed, he could take this same bladder, and in a wonderfully short time could give it permanently the full rounded outlines of its inflated condition, so that it would not alter its form in the least, though it were cut into twenty pieces. I have seen bare skins quite as thin and tender as the membranes of the bladder preserved in this fashion, and still retaining the plump roundness of the living form.

Indeed, to my taste, this art never shines out to more ad-

vantage than when dealing with naked skins. Whenever fur and feathers may be found, the preserver may cover his errors by means of "coaxing" the hair or the plumage, so that none but an experienced eye could detect the distortion; or additional feathers or patches of hair may be inserted, so as to hide the deficiencies. But when we come to deal with the bare skin, we find the severest possible test of our handiwork. No error can be concealed, and all shortcomings are glaringly prominent, so that the merest novice can perceive them. By this process, however, which really seems to rejoice at difficulties and to grapple with impossibilities, a triumphant victory is gained over the stubborn substance, which has successfully baffled all operators, save one, in their attempt to reduce it to submission. In the master's hand the bare skin is plastic as clay; he moulds it as he pleases, does what he likes with it, and, reversing the mythic fable of Pygmalion, he converts into statuesque rigidity the once active being, though, like that favoured artist, he inspires into the lifeless image the fire and energy of the breathing and living form.

See even the insects. We all know how insects are generally preserved; we stick a pin through them, we "set" them, we dry them, and when they are set we transfer them to our cabinet. If we have a large beetle which we wish to exhibit with opened wings, or if we set one of the fat-bodied moths, we are at a loss to prevent the abdomen from putrefying or shrivelling, or to guard it from the "grease" that damages so many fine specimens. Then, in order to keep off the mites and other destructive beings, we put a supply of camphor in the drawers, and think that we have done all that can be done.

But in this museum we have insects of various orders displayed as they are in life—walking, climbing, flying, feeding, or reposing, and all endowed with the peculiar attributes which they displayed in life. There is no camphor about them to condense gradually upon their surface like moisture on a cool glass, no pins are stuck through them, and their bodies are as plump and their colours as vivid as when they lived and breathed. Of the details I know nothing, except that a child can learn the process in half an hour; but of the results I can only speak with unmixed eulogy, having often tried my own hand upon such subjects, and having learned from my own failures how to appreciate such signal success in another.

People will scarcely believe me when I tell them about these wonderful specimens, and imagine that enthusiasm must have caused exaggeration; yet I have studiously restrained the words of commendation which would flow so readily from the pen, and, if anything, have understated the facts.

I have gone into the shops of professional "naturalists,"

and have been told that "Mr. Waterton's system is all a humbug, sir; nothing in it; it's as old as the hills. Corrosive sublimate is worthless, it spoils the colours and rots the feathers; nothing like arsenical soap," etc. Then, I have been told that no specimens can be prepared by that method unless every feather is perfect. Why, one of its chief characteristics is that it permits the operator to "make up" to any extent that he chooses, to substitute good feathers for bad, to remove a damaged limb and replace it by a sound one, and to make these changes without the possibility of detection. Then, I have been told that the specimens cannot endure damp, whereas they are expressly designed to resist the effects of moisture; and I have been informed that the corrosive sublimate has turned out a failure, and that the specimens are dropping to pieces.

They certainly were not dropping to pieces four days ago, and considering that forty years have elapsed since some of them have been preserved, and that it is impossible to distinguish between those which have stood in the museums for forty years and those which have scarcely occupied it for as many days, such specimens do not exactly look as if they are dropping to pieces. When a stuffed bird or animal is dropping to pieces, it cannot usually be taken up by a single feather or pinch of fur, and swung about without injury; nor will it endure crumpling and rude handling without losing fur or feathers in plenty. Yet I have seen specimens some thirty years old treated in that unceremonious manner, and without suffering the least injury.

We ask ourselves why a system which has proved itself to be so thoroughly successful should not be adopted throughout the kingdom? Why should we be doomed to see some of our most valuable specimens slowly perishing before us, while an infallible remedy is so near at hand? Why are we doomed to see such horribly unsightly objects as are presented by the stuffed skins in the museums, while a system has been in use for forty years which will reproduce the forms of the dead animals as they existed in life, giving even to the face, the nose, the lips, the ears, and all bare spots on the skin, the soft rotundity of the living texture? So wonderfully does this process restore the form, that even the peculiar tongue of the shoveller duck is seen in the open mouth, full, plump, and fringed as in life; and the webs upon the feet, and the little fleshy wrinkles about the eyes, are rounded, undulating, and to the eye as soft as in the living bird, though to the touch they are hard as horn. There is no doubt as to the success of the process, and the inventor is always ready to prove his assertions by pointing to his work. He does not merely say, "I can give to a monkey's skin the exact contour

of the living form, without the aid of wires or any internal support," but says, "I *have* done this; come and see it."

There was but one apparently valid objection to the system, and that is now removed. Professional taxidermists were accustomed to say that the process might be very well adapted for a gentleman of means, who had not to work for his living, but that they could not afford to spend six or seven weeks on the preparation of a single specimen. Now, in the first place, this objection is quite invalid, because it infers that each specimen requires undivided attention until it is dry, whereas it only needs a few minutes' work daily; so that, in fact, any taxidermist who wished to earn his livelihood by his art, could do so as easily as by the present system, by always keeping a number of specimens in hand. In the second place, since its first discovery the process has been greatly simplified and expedited, so that hours, or even minutes, will now do the work which formerly required weeks for its completion.

I write these lines, not to praise the inventor of a system which requires no eulogy, but to mention that it has been greatly simplified and improved; and to ask whether the art is to die with its originator. Will no skilful manipulator take it up? or are we to permit an art to perish which has produced such marvellous results as may be seen in the chimpansee, the peacock, and the eider duck in the museum at Walton Hall? I look upon the question as one of national importance, as affecting the character of our national collections. It is impossible to visit the museum at Walton Hall, and then to walk through the galleries of the British Museum, without feeling much humiliation at the contrast between what the specimens are, and what they might and ought to be. It is just as easy to prepare the skins in a right as in a wrong way, and if the former mode had been chosen, our national collection would long ere this time have assumed the pre-eminent position which we all wish it to attain.

THE BRISTLE-MOSSES.

BY M. G. CAMPBELL.

Amid the varied beauties of spring and summer, the ordinary observer overlooks many which, to the diligent investigator of Nature's secrets, microscope in hand, will afford sources of infinite marvel and ever new delight. Among these may be reckoned those dingy little patches of a brownish-coloured moss which compose the family of *Orthotrichum*, and are found growing upon trees, stones, and walls. As if requiring a nutriment less gross than common earth affords, they appear never to grow upon soil.

They are named from ὀρθὸς, straight, erect, and θρὶξ, hair; the calyptra being covered, in most of the species, more or less densely, with upright, hair-like processes, not matted into it, as in the *Polytrichums*, which we noticed in our May number. Unlike them, too, the capsule, instead of growing on a long seta, or fruit-stalk, is chiefly immersed in the leaves, or exserted on a short pedicel; while their comparatively small size and dingy appearance causes them to be frequently passed by as unattractive and insignificant, and *all alike;* whereas twenty-three species are enumerated by Wilson in his *Bryologia Britannica*, each sufficiently distinguished one from another. The *Bryologia Europœa* describes thirty-four; but we shall find enough to do with our native species at present.

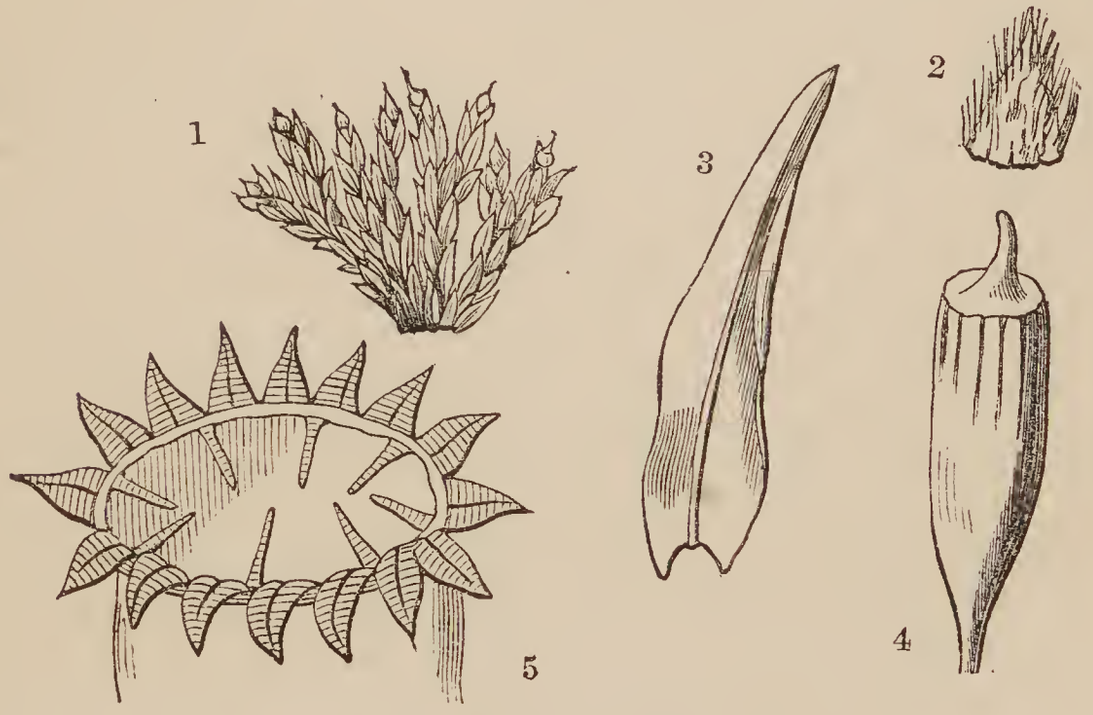
They ripen their fruit in the spring and summer, but the fruit requires twelve months to mature after the first appearance of the bud from which it originates. Thus, every month in the year presents some new phase of development. The inflorescence, though sometimes dioicous,* is usually monoicous, *i.e.*, the barren and fertile flowers are found on the *same plant*, though not on the same *receptacle*. To the latter form of growth the term *synoicous* is applied.

The *Orthotrichums* are perennial; their stems dichotomously, or *forkedly*, branched; their leaves are concave, keeled, nerved, and lanceolate, spreading from an erect base, the upper ones crowded into a small tuft, the lower ones more distant; when dry, twisted or curled, seldom straight, but remarkably susceptible of moisture; and, however closely imbricated or variously contorted in a dry state, immediately after contact with water they expand, and become more or less spreading. The barren flower in the monoicous species is either terminal or axiliary; at first in close proximity to the fertile

* From διοικέω, to live separate or apart; applied to such mosses as have the barren and fertile flowers on distinct individuals.

flower, but, as the fruit ripens, it becomes distant by the growth of the plant.

There is a sufficient resemblance in the members of the group to enable the student who becomes acquainted with one individual, easily to recognize the family likeness in other individuals of the tribe. The capsule is longitudinally marked with eight—sometimes, but rarely, with sixteen—coloured striæ, one British and a very few exotic species excepted. These striæ alternate with the teeth of the peristome, and in the dry state form prominent ridges. They consist of larger cellules than the other parts, and are more deeply coloured than those in the rest of the tissue of which the capsule is composed. When their number is more than eight, the intermediate striæ are shorter and unequal. The calyptra is large, campanulate, *i.e.*, shaped like a little bell, and the base somewhat torn into short segments. At a very early stage it is marked with furrows, but the hairs on its surface are not developed until a later period.



ORTHOTRICHUM RUPESTRE.

We give an illustration of *O. rupestre*, as typical of the genus. The illustration represents—Fig. 1, the moss of the natural size; Fig. 2, the calyptra, magnified; Figs. 3 and 4, the capsule and leaf, still more magnified; Fig. 5, the mouth of the capsule, very greatly magnified, showing the teeth and cilia, which alternate with and separate them into two couples between each pair of cilia.

Orthotrichum rupestre may be found growing in little tufts on rocks, chiefly in mountainous districts; hence its common English name, *Rock Bristle-moss*. The stems are loosely matted

together, elongated, branched, and decumbent* at the base; the leaves, when moist, spreading; somewhat recurved, lanceolate, and erect when dry; the capsule what is called *pyriform*, or pear-shaped, with eight faint striæ; calyptra campanulate, very hairy; teeth of the peristome apparently sixteen, in pairs, but really thirty-two, each apparent broad tooth consisting of a pair so connected as to seem but one; cilia eight linear-lanceolate. The capsule, when dry, is slightly ribbed on the upper part only. The spores are small and brown. The lid is convex, with a short beak. The calyptra yellow, and large enough to cover the greater part of the capsule. Fruit, ripe in July and August.

A more common species is the *Orthotrichum diaphanum*, or White-tipped Bristle-moss, which may be found on trees, walls, roofs, and old palings, growing in little patches; the stems loosely tufted and sparingly branched; the branches dichotomous, or forked; leaves almost piliferous, the acuminated point diaphanous and subserrulate; the capsule oblong, oval, half-immersed, pale yellowish brown, of very thin texture, and very obscurely ribbed. When dry, its little crimson, or sometimes bright scarlet lid, may be seen just peeping out of the leaves at the terminal points of the stem and branches. The teeth somewhat resemble those of *O. rupestre*, but the cilia between are sixteen, instead of only eight, and the calyptra is naked, or sometimes has a few scattered hairs of a pale yellowish-brown. The teeth, also, are spreading when dry; while in *O. rupestre* they are erect when dry. The accuminated slender diaphanous points sufficiently distinguish *O. diaphanum* from all others.

Another species is *O. crispum*, or Curled Bristle-moss, frequently found on trees. The leaves of this species are crowded, spreading, contorted, much twisted and crisped when dry; linear-lanceolate, ovate, and dilated at the base, slightly undulated; the capsule with a long, tapering apophysis imperceptibly passing into the short, thick pedicel, giving a narrow clavate, or club-shaped appearance to the fruit, which is widely striated, and contracted below the mouth. The inner peristome is composed of eight, sometimes of sixteen, cilia, which consist of a double series of cells. Spores brown and small; capsule not immersed in the leaves, but exserted on a short, coarse pedicel.

* "Decumbent (Decumbens, lying down) applied to stems when they recline upon the surface of the earth, but have a tendency to rise again from their extremities."—*Henslow Dict. Bot. Terms.*

THE PYCNOGONOIDEA (SEA SPIDERS).

BY GEORGE HODGE.

(*With a Tinted Plate.*)

The generality of persons who have devoted any time to researches in marine zoology must at some time or other, during their shore-hunting and dredging expeditions, have come across one or more species of Pycnogons—possibly *Pycnogonum littorale, Phoxichilidium coccineum*—or even some of the less common *Nymphons*. We, however, hear very little about them, and it would appear they are very imperfectly understood, judging from the statements made in the scanty literature of these animals.

Little has been done in this country towards cataloguing the native species, or unfolding their life-history. They have, in most cases, been hastily passed over, either as unworthy of a lengthened description, or as being of an obscure tribe, little understood, and little cared for by those for whom information on allied animals was written. This is to be regretted, for it has had the effect of retarding the progress of observation on the habits and singular economy of these animals, and, further than this, it has, in a great measure, led to the often-broached discussion of their true position, which would not long remain unsolved were their life-history clearly made out. It is singular that, whilst other animals have been most diligently studied, and the advance in the knowledge of the habits and minute anatomy of obscure animals is something marvellous, we find the *current* information relative to the Pycnogons little advanced during the last eight or ten years.

By some authors they are considered as being closely allied to the *Arachnida*, as opposed to those who maintain they are a low grade of crustacea. Dr. Leach placed them amongst the former, forming an order for their reception, which he named *Podosomata*, but he subsequently "became so perplexed with doubts and difficulties relative to this family's relationship to other animals, that he dissevered it entirely from the system, and threw them into an appendix."*

Even at the present day they are differently placed by different authors—a most unsatisfactory state of things.

They are pretty generally diffused, being alike brought from the Arctic, Atlantic, and Pacific seas. It would, however, appear that they are more especially inhabitants of a cold or temperate sea; possibly the Scandinavian waters have produced more species than any other locality. Their size varies con-

* *Samouelles' Ent. Comp.*, 305. London, 1819.

siderably, some being only one-eighth of an inch in greatest span, whilst others attain as much as eight inches from the tip of one limb to the tip of the opposite—the dimensions of a specimen of *Nymphon gigantea* from the Shetlands, in the possession of Mr. Spence Bate.

The most striking peculiarity noticed in a Pycnogon when first seen, is the extraordinary dimensions of the legs, and the small size of the body—the latter, in most cases, being a short segmented tube, little thicker than the limbs at their origins. This body, or thorax, is divided into four segments, by means of three constrictions—the first, or anterior segment, carries the rostrum, oculiferous tubercle, first pair of legs, palpi, and foot-jaws when present, and in the case of the female the false feet; the two next segments carry the second and third pairs of legs, whilst the fourth or terminal carries the fourth legs and abdomen.

The rostrum consists of a blunt rounded organ, perforated at the free end, and through which the animal imbibes nourishment. The precise method of alimentation is not clear, but judging from the character of the œsophagus, which appears to be furnished with cilia, it is the opinion of the writer that a current is produced by their action which carries the food into the gullet.*

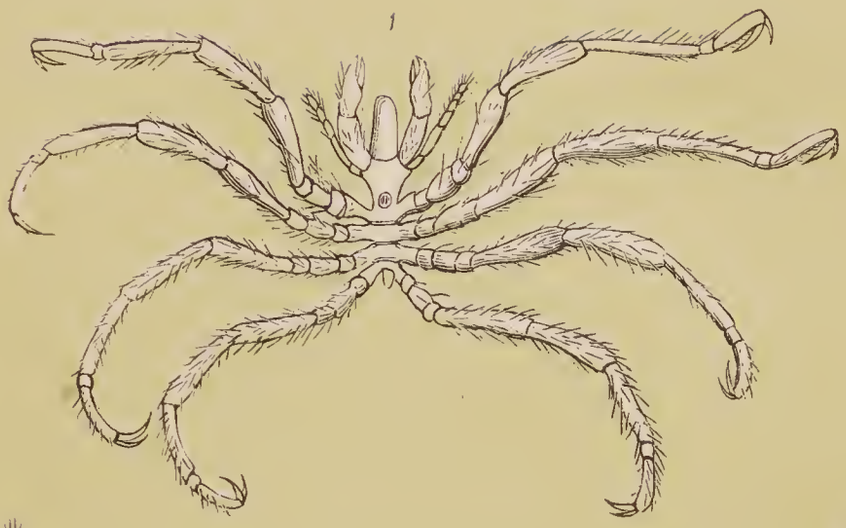
The length of the rostrum varies in different species; in some cases it exceeds the length of the foot-jaws, and in other instances it is much shorter than these appendages.

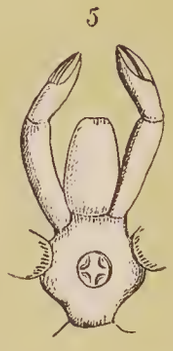
The foot-jaws are represented by two strong nipper-like organs, the office of which it is difficult to determine. Any one examining a *Nymphon*—for example, *N. gigantea*—would be likely to consider them connected with the procuring and conveying of food to the mouth or orifice of the rostrum, in the same way as a crab uses its fingers. Such, however, has not been noticed in the Pycnogons; and when it is remembered that some genera are destitute of foot-jaws, and others have them so placed, and of such dimensions as to render their use for that purpose impracticable, it may fairly be surmised that their office must be otherwise accounted for.

The palpi consist of two filiform appendages, varying in length and in the number of joints.

The oculiferous tubercle is a wart-like protuberance, more or less elevated, and varied in shape, according to genera and

* The food of these animals has not been satisfactorily determined. Fabricius was of opinion that they preyed upon the soft parts of Bivalved Molluscs. The writer has frequently taken *Pycnogonum littorale* upon Actinæ. In one instance, a specimen of *P. littorale* was found with its rostrum firmly embedded in a small specimen of *Bunodes crassicornis*, which it was evidently preying upon, the "crass" showing its dislike to its visitor by the emission of a large number of "nettling-threads."





Pycnogons (Sea Spiders.)

species, and having at the upper, or free end, four dark coloured spots, usually of a crescentic form, which represent the eyes.

The true legs, of which there are eight, are eight-jointed, the terminal joint being usually furnished with one strong and two small claws. The false feet, or "egg-carriers," of the female are produced from the under-side of the anterior segment of the thorax, usually near the origin of the first pair of legs; they generally consist of five to ten joints, the last three or four being provided with leaf-like setæ of curious form and structure, near to which the egg masses are found attached.

The abdomen, which resembles an elongated wart, either one or two jointed, is attached to the *upper* surface of the fourth segment of the thorax. Compared with the thorax, it is a mere rudiment of the organ represented, and in this respect contrasts most forcibly with the Arachnida, in which the abdomen is a prominent feature.

The Pycnogons generally are more or less furnished with bristles, either in the form of hairs or spines; in some species the latter are so large as to have given a character by which to distinguish them.

Returning to the legs, and their great disproportion to the other organs and parts, the surprise must be rather increased than abated, when it is stated that the food when taken into the stomach freely passes into the legs, as far as the sixth joint; in fact, the alimentary canal is not confined to the body alone, but sends out prolongations, termed cœca, into the legs, and also into the foot-jaws when present. During the movements of the animal, the food contained within these cœca is forced into that part of the stomach which is contained within the thorax, the pressure thus exercised forcing particles of partially digested matter into the cœca of other limbs. The food, during the continual motion thus imparted to it, is seen to undergo digestion, the residue being finally expelled through the abdomen.

The manner in which the biliary fluid is produced and applied is unknown; it would, however, appear that as the digestive system of these animals is of a peculiarly degraded type, we must not expect to find any special apparatus for the purpose.

The females only differ from the males in the possession of the false feet before alluded to. The generation of these animals is unknown, and it is even doubtful whether any author has hazarded an opinion of the mode in which the eggs are fertilized. All we know is, that at certain seasons they appear upon the false feet of the female, and from being at first filled with a mass of granular matter, they gradually change their

character, and develope into embryos as unlike their parents as can well be imagined, showing that they must undergo some wonderful metamorphosis before they attain the characters of the adult individual.

The larval state of several species has been figured and described by Kroyer* and others, but their development into the perfect animal is involved in much obscurity, for with the exception of a series of observations made by the writer on *Phoxichilidium coccineum*,† there has been no published record of the several changes they must go through in attaining the adult form.

The circulation and respiration of the Pycnogons have at different times occupied the attention of several naturalists. Amongst the number Quatrefage,‡ who published an elaborate paper. He, however, failed to make out anything particularly conclusive, and whilst he did good by bringing together scattered observations, he did harm by stamping with the authority of his name certain views which have proved entirely erroneous. From the observations he made upon a species of *Phoxichilus*, he arrived at the conclusion that there was no regular circulatory system; an opinion since contradicted by Zenker,§ Krohn,‖ and Williams,¶ and which any one can readily demonstrate by the careful manipulation of a suitable living specimen, which is seen to possess a dorsal vessel, serving the purpose of a heart, with its sets of valves. The current of fluid, or blood, traverses the thorax and limbs by a series of pulsations, usually forty in a minute, the stream flowing with considerable regularity, unless it meets with any opposition, as the doubling of a leg, which disturbs the circulation of that part alone, the loss of time being made up by redoubled speed when the stoppage is overcome. Tracing the current from the dorsal vessel *upwards*, we find it urged towards the rostrum; when near its apex, it branches out at right angles, and flows over the under surface of the thorax to the several limbs, which it enters at their upper sides, and courses up as far as the last joint, returning by the opposite side to the dorsal vessel, which

* "Note sur les Metamorphoses des Pycnogonides," in *Ann. Sciene Nat.* 2 Ser. Zool. tom. 17, 1842, pp. 288—292.

† "Observations on a Species of Pycnogon (*Phoxichilidium coccineum*), with an attempt to explain the Order of its Development. By George Hodge. *Annals and Mag. of Nat. Hist.* January, 1862.

‡ "Mem. sur l'Organization des Pycnogonides," in *Ann. Sciene Nat.* 3 Ser. Zool. tom. 4, 1845, pp. 69—83.

§ "Zenker, Wilh. Untersuchungen über die Pycnogoniden," in *Müller's Arch. f. Anal.*, 1852, pp. 379—391.

‖ "On the Heart and Circulation in the Pycnogonidæ." *Annals and Mag. Nat. Hist.* 2 Ser., vol. 16. 1855.

¶ "Dr. T. Williams on the Mechanism of Aquatic Respiration in Invertebrate Animals." *Annals and Mag. Nat. Hist.*, vol. 13, 1854, p. 300.

it enters by the valvular opening near the origin of the limb.

This plan of circulation may serve a twofold purpose, for not only may the ordinary restoration of tissues be effected thereby, but at the same time the corpusculated fluid may receive the necessary æration, which the absence of any regular set of organs for the purpose would demand. Accordingly we find the outer surface of these animals is studded with innumerable little warts, and these under a high magnifying power are seen to contain minute openings, or pores, through which a simple cutaneous respiration is effected by contact with the surrounding sea water.

The presence of a distinct nervous system is readily noticed, consisting of four large "centres" seated on the *under* side of the thorax, one in each segment; the anterior communicates with the brain, foot-jaws, etc., with the former by means of two bands uniting immediately beneath the oculiferous tubercle, which is the seat of the brain, and with the foot-jaws by two similar bands, one to each. From each "centre" also proceed two nerves, which pass into the legs, and, according to Quatrefage, divide into two or more bands shortly after entering the limbs.

The Pycnogonoidea are divided by systematists into two families, *Nymphidæ* and *Pycnogonidæ*. The former contains Nymphon, Ammothoa, Zetes, Pallene, Phoxichilidium, and Pasithoe, and the latter Pycnogonum and Phoxichilus.

These various genera are most readily distinguished from each other, each possessing characters peculiar to itself. The several species are, however, difficult to name, for although the characters of each are pretty constant, the differences perceptible to the ordinary observer are very slight, excepting in a few cases; the genus Nymphon, in particular, is very puzzling, and it is only by an extensive series that the various species can be named with certainty.

The characters by which the genera are determined are thus stated by Dana:—

Nymphon.—Antennæ two branched, the one thicker and furnished with fingers, the other five-jointed. Front scarcely narrower at the base. Abdomen one-jointed.

Ammothoa.—Like Nymphon, but the larger branch of the antennæ nine-jointed.

Zetes.—Antennæ having two slender branches. Front much narrower at the base. Abdomen two-jointed.

Pallene.—Antennæ with one branch, which is furnished with fingers, moderately thick. Abdomen one-jointed. First (egg-bearing) feet eleven-jointed.

Phoxichilidium.—Like Pallene, but first (or egg-bearing) feet five-jointed.

Pasithoe.—Antennæ with only one slender branch, unprovided with fingers.

Pycnogonum.—Feet short; egg-bearing feet ten or eleven-jointed. No antennæ.

Phoxichilus.—Feet very long and slender. No antennæ.

The foregoing generic characters, taken in connexion with the plate accompanying this paper, will enable any one to refer such specimens as may be obtained to their proper genera; and as the season for sea-side trips is nearly here, the present is a fitting opportunity to direct the attention of those in want of a novel study to the animals in question, and it is a subject that cannot fail to reward the painstaking observer.

Explanation of the figures.—Fig. 1, *Nymphon hirtipes.* Fig. 2, Rostrum, foot-jaws, palpi, etc., of *Ammothoa robusta.* Fig. 3, Rostrum, palpi, etc., of *Zetes hispidus.* Fig. 4, Rostrum, foot-jaws, etc., of *Pallene brevirostris.* Fig. 5, Rostrum, foot-jaws, etc., of *Phoxichilidium coccineum.* Fig. 6, Rostrum, palpi, etc., of *Pasithoe vesiculosa.* Fig. 7, Rostrum, etc., of *Pycnogonum littorale.* Fig. 8, Rostrum, etc., of *Phoxichilus spinosus.*

THE CAVE OF BELLAMAR.

BY GEORGE E. ROBERTS.

Of late years caves have been explored rather upon palæontological grounds than physical, and those which have yielded bones to the naturalist have ranked higher than that more numerous group, the stalactitic and stalagmitic, products of which only enrich the cabinets of the mineralogist. But if palæo-zoologists have a special greeting for bone-yielding caves, the interest of the physical geologist remains fixed upon those larger caverns, formed by various agencies in the material which envelopes the ball of the earth. Some have resulted from chemical forces, like those subterranean caverns upon Etna, formed, as Sir C. Lyell has taught us, by the induration of the lava during the escape of great volumes of elastic fluids; and others from phenomena of ice-and-water action, as exampled in the "ice-vaulted wildernesses" described by Dr. Wallich as lying beneath a glacial covering in Greenland, wherein we may fancifully suppose Necks, and other genii of the thick-ribbed ice, have their abiding place. Or, again, we have the better-known class of caverns typed by the marble grotto of Antiparos, the now smoke-dimmed glories of which appear to be far eclipsed

by the wonderful beauty of the newly-discovered cave to which I am about to direct attention. This cave is situated in a limestone hill two miles from the bridge of Bailen on the San Juan River, near Matanzas, in Cuba. No reliable intelligence as to the geological age of the rock has reached England, but the hill is probably a point in the range south-west of Matanzas, described by the Baron von Humboldt as a compact lithographic limestone, and called by him "Calcaire (Jurassique?) de Guines," an adoption, probably, of its local name.

Cuba is almost a *terra incognita* to the naturalist; perhaps, with the exception of Madagascar, no country has been so little studied; yet it must be a very paradise for beauty, and for the number and variety of its natural productions. No less than 374 species of ferns are met with upon the island, and in molluscan and zoophytic fauna its shores are exceedingly rich. Scarcely any description of these has yet been attempted, and until the Spanish Government places greater facilities in the way of travelling naturalists, we can hardly expect to hear much of its natural wealth. Perhaps the most important geological observations upon Cuba are those contained in a paper by Mr. R. C. Taylor (*Phil. Mag.*, July, 1837). In describing the Savana in the north-east part, he speaks of some "white limestone mountains," which may be of older geological age to the rock which contains our cave. The Savana is dotted with what appear to be "snow-white basaltic pillars," formed however of this limestone, and shaped of course by water-action. The effect of these, says Mr. Taylor, shooting up like enormous crystals among the dark green foliage of a tropical forest, is equally grand and singular. This limestone forms massive hills in the eastern part of the island, and exhibits extensive fissures, which afford hiding-places to the numerous wild dogs which infest the country. The most remarkable of these hills is the one called La Silla, a honeycombed mountain of white limestone, a bare and nearly perpendicular rock, about 1200 feet high, which rises like a huge group of snow-white crystals. About 150 feet below the summit is an extensive suite of caves, which were explored to the depth of 300 feet by Mr. Taylor and his party. The interior of one is said by him to resemble an Anglo-Norman crypt, having a heavy groined roof, and pillars of constantly-increasing stalactite. A thick layer of "cave earth" concealed the floor, and was found to be mainly composed of the exuviæ of bats, mixed with myriads of land-shells. This was fast hardening into a bed of shelly carbonate of lime, being aided in the process by the stalactitic droppings from the roof. Elsewhere in the mountain, fissures were seen by Mr. Taylor to be entirely filled up with an analogous deposit of more ancient date, but which contained the same

genera of land-shells and some bones of the cave-rat, being, in fact, an osseous breccia, nearly allied in appearance to those of Gibraltar and Malta.

Similar caverns to those of La Silla, though of younger geological age, have been described by Captain Nelson (Proc. Geol. Soc., vol. ix. p. 205) as occurring in "coralline crag rock" at Long Cay and Rum Cay, in the Bahamas, and as containing like organic remains. Basset's cave also, in the Bermudas, which extends inland from the sea-wall for nearly a mile, is of the same recent origin; and so, too, was the pretty little cave at Tucker's Island, with its sparry-fretted ceiling, which had to be destroyed, as it lay in the line of works ordered for the Bastion. From another cave in the Bermudas, having no apparent entrance, a Mr. Anderson obtained specimens of a breccia, made up of bird-bones and land-shells, cemented by stalagmite, which are now in the foreign collection of the Geological Society.

The cave of Bellamar, which, if the accounts given are reliable, must certainly be the queen of West Indian caverns, was accidentally discovered by a quarryman opening up a deep well-like rent in the rock, which proved to be the entrance.

The little guide-book published by Señor Manuel Santos Parga, owner of the property, gives the following description of it:—"The first, or entrance hall of the cavern, has been named the Gothic Temple, from its vast and severe beauty, reminding one of the solemn nave of some ancient cathedral. It is 900 feet in length by 240 wide; in parts the roof is 60 feet in height. Magnificent stalactitic pillars adorn it, drooping from the roof to the floor; the largest of these measures 60 feet in height, and has a width varying from 8 to 21 feet. The stalactitic droppings have simulated in it the appearance of a giant mantle, with stately and capacious folds. Beyond this immense chamber lies the Gallery of the Fountain, a corridor 2400 feet in length! In the centre of it is seen the spring which gives its name, hemmed in with the loveliest stalactites. Walls, roof, and floor are alike invested with a crystal robe of the purest and most glittering white. At the end of the long gallery the traveller comes to a fine arch called the Devil's Gorge, a few yards beyond which the stalactites and stalagmites are commingled so as to form one vast screen of transparent alabaster. One of the gems of this charming group is called the Embroidered Petticoat, being a beautiful hollow stalactite, as smooth as marble, three feet in height, and having a symmetrical edge, six inches wide, made up of large crystals. But perhaps the most dazzlingly beautiful of these cavern-halls is the smaller one named the Hall of the Benediction, which lies still farther from the cave's mouth and

deeper in the mountain. It obtained its name from a blessing having been pronounced upon it by the bishop in a moment of enthusiasm. This is a chamber of unsurpassed beauty. Floor, walls, and vault are alike of the purest white; slender columns of stalactite covered with thousands of small crystals form aerial vistas, or droop pendent from the roof like the most fanciful combinations of Eastern art. One of the most striking of these, a large stalactitic mass, which falls like a transparent cascade with an undulating surface, has been named the Mantle of the Virgin. From beneath it issues a stream of water, the source of which lies deeper among the yet unexplored recesses of the cave. Still farther we come to the Gallery of the Lake, remarkable for the stalactitical mass called the Snow Drift, and this is at present the terminal point reached. The Lake of the Dahlias, which hides some marvellous crystallizations in the form of those flowers, stops farther progress. Returning through the Hall of the Benediction to the Gallery of the Fountain, the visitor turns into a side passage near its centre, and traverses Hatuey Gallery, named in honour of an Indian chief, famous in the early history of Cuba, by reason of a slender, well-proportioned stalactite, which stands like a chieftain's lance, beneath a high vault. Here is also a lovely group of these fairy-like productions, called the Closet of the beautiful Matanceras; and another resembling a canopied niche of the richest Gothic tracery. Many of the stalactites possess the property of double refraction, and occasionally the crystallizations are tinted with the delicate hues of the violet or rose, or shine with the rich lustre of gold."

The cave of Bellamar runs from west to east, and attains a maximum depth of 360 feet. The temperature is in no part beyond 80 deg. Fahr. As may be expected, it has become, from its proximity to the wealthy and populous city of Matanzas, a place of great resort, and the owner evidently reaps no small advantage from the show. The entrance fee charged is a dollar for each person. For this guides and lights are provided; in addition to which the visitor finds good paths through it, fixed lights at the chief points, and small bridges thrown over places which need them. An excursion through it takes from two and a half to three hours. I have not heard that any natural communication with the surface exists, but no scientific exploration of it appears yet to have been made.

BEACH PEBBLES.

BY S. M. SAXBY, R.N.,

Principal Instructor of Naval Engineers, H.M. Steam Reserve.

About a dozen years since a noble invalid was sent by his physician to seek in the Isle of Wight that retirement which the necessities of impaired health demanded. Whatever repose the body might have sought on the luxurious couch of shingle which nature provides so amply in some parts of that favoured island, the habitual activity of mind so well known to distinguish the individual referred to, soon found an interesting exercise in examining the shingle itself. But who could have expected the result? It is enough to assert that, in the hands of the noble lord and two accompanying members of his family (and under my own roof too, where I had the resources of my laboratory at hand to test any specimens of which I had doubts) I saw nearly every gem known to the lapidary; say about 500 specimens, all of which had been found in the shingle at the back of the island, within a range of about four miles of coast line. Add to this the result of my own subsequent researches in that and various other parts of the shore, and we have the indisputable fact that a hitherto neglected source of amusement exists of which not only the ordinary pleasure-seeker but the convalescent or invalid can avail himself in such localities.

My object is to show how best to do it.

It is not, for the present, necessary to adduce geological theories as to the origin of these beds of shingle, for it is easy to conceive that the various changes which have, through ages, altered the land surface, would, from the abrasion and destruction of rocks of every kind, present occasional accumulations; and these collections of *débris* would be seen to advantage were the softer portions removed by the action of water; and especially the harder crystalline substances, which are found in the remains of the older and unstratified rocks, would in such accumulations be thrown together as we find them. The gems of the lapidary are of the latter description.

In searching a shingle-beach, it should be borne in remembrance that all real gems (the opal excepted) will scratch window-glass; also that (with the same exception) no gem fit for the purposes of the lapidary has a specific gravity less than that which forms the bulk of the shingle-beach; consequently hardness and specific gravity form the principal tests to be used in determining the quality and value of specimens.

Every fragment of stone having transparency or translucency is worthy of examination. Every piece exhibiting colour differing from the ordinary stone which forms the bed is worthy a place in the pocket until leisure at home determines its name and worth. The most brilliant gem owes its beauty either to repose after its formation as a crystal, or to the skill of the lapidary, who renews the surface after abrasion among other stones. Hence shining fragments among the rolled and rounded stones of the beach are not to be expected. Constant attrition renders even the choicest rock crystal apparently translucent. The same applies to other substances; as an example, I have in my collection one of the most handsome of "moonstones." I found it on the shore at Bonchurch, Isle of Wight. Doubtless many precious stones are cast aside from want of this consideration, especially with young collectors. It was only when I dropped it into water in a test tube and used the pocket lens, that its peculiar *chatoyance* was detected. Of course, the lapidary's care soon revealed its great beauty, although the specimen is only one-sixth of an inch long.

And further, the finest beryl or aqua-marine, when found on the beach, might easily be mistaken for a piece of green glass bottle; indeed, fragments of green and blue wine bottles have been an abundant source of disappointment and annoyance to the collector; but mistakes of this sort are easily avoided by breaking a flint and trying its sharp angle against the supposed treasure, for if it be glass, the flint will scratch it, whereas a beryl will slightly mark flint.

As found in the beach, the finest blue sapphire would be but a darkish dingy-coloured stone. The brightest emerald, which is scarcely harder than flint (being indeed a green beryl) is, in its rough state, a dull, almost opaque-looking greenish stone.

It may be admitted, as a general rule, that the clearer a stone or crystal from the shingle-bed is seen to be, the harder and more valuable it is likely to prove on further examination.

But even were the choicer gems totally unknown to our coast, enough may be collected in the members of the quartz family itself to create a pleasant source of lasting interest in the examination of a shingle-beach; and this will appear plainly from the few hints and descriptions which follow.

The great difficulty with those who collect stones is to know under what names to rank them. Quartz (which is pure silica) enters so largely into the composition of rocks, and is seen under such varieties of aspects and combinations, that no other class of minerals can furnish a like amount of interest and even usefulness; for the beauty of some of its combinations is scarcely to be surpassed by anything in nature. Our attention will therefore at present be given to a few general descriptions

which may assist examinations on the shore, rather than to scientific arrangement and details.

Almost every watering-place has its local "diamonds." Ventnor, Bristol, Brighton, etc., have long been noted for the purity of the pieces of rock crystal found in their sea-beaches. As most of these, when discovered upon the shore, have lost the characteristic form of their original hexagonal prism, it is only by superior specific gravity and hardness of the diamond that an ordinary observer can distinguish the difference.

It is best to select the half tide, or "half beach" portion of the shore for examination, for there the shingle is commonly shallower, and the bottom of the bed, as well as the surface of the underlying sand, are more easily accessible, and it is *the* place at which gems in particular are likely to reward the seeker. It is even well and advisable to examine the upper inch in depth of the sand itself.

Under the terms quartz, carnelian, chalcedony, jasper, and agate are to be found every variety of the family we have under consideration; and attention to the following distinctions of character will enable any one to name and arrange specimens for the cabinet.

Mineralogists have adopted ten substances (represented by numbers 1 to 10) as tests for the hardness of minerals; but, on the beach, it is enough to be provided with a piece of common window-glass, the comparative hardness of which is about 5 to 5½ in the scale used in works on mineralogy; and also with a piece of felspar, which is the flesh-coloured crystalline substance found in common granite, and it represents a hardness of 6; also a piece of flint, which has a hardness of 7 in the same scale; but in testing, care should always be taken to ascertain from which of the substances brought into contact the streak is obtained, for at times it is not easy to determine. It is best to remove the dust from the streak in order to see if the testing mineral has really left its mark from having cut the surface.

Specific gravity is easily ascertained by weighing a specimen first in air and then in water (in the latter operation the object, if small, may be attached by a little piece of bees'-wax to a hair fastened to one scale, and then allowed to dip into a tumbler of rain-water); on dividing the weight in air by the loss in water, the quotient will be the specific gravity, water being considered as 1. The use of bees'-wax will scarcely affect the result, because it is nearly of the same density as water. With small specimens it is necessary to weigh to tenths of a grain. These weights are easily procurable, and greater accuracy is seldom necessary for the purposes of the pebble collector.

A very ready method of distinguishing quartz crystals from a large number of others, is by trying if they can be scratched with a knife. Steel will not scratch quartz; and further, quartz crystals generally show a horizontal striation or striping on some faces of the hexagonal prism (at right angles to the longer axis of the crystal); they will moreover strike fire with steel.

As to the varieties of quartz, one has a peculiarly dark green colour, and is called "prase." Milk quartz is a translucent variety, owing its milky colour to a metal, and we can generally in it detect a slight reddish tinge. It differs from chalcedony in not having a blueish tinge. Where the shade of red is very distinct, the specimen generally has more transparency, and is then known as rose-quartz.

A very elegant variety, of a yellow colour, is the well-known Cairngorm. It much resembles topaz, but wants both the hardness and specific gravity of that beautiful gem. The specific gravity, for instance, of quartz being 2·6 to 2·7, while that of topaz equals 3·4 to 3·6. The hardness of quartz being 7 in the scale, and of topaz 8.

The mineralogist does not limit the term "amethyst" to quartz of any particular colour, but uses it broadly as indicating coloured varieties of semi-transparent quartz. Popularly the word designates a kind which is tinged of a delicate violet from the presence of manganese.

Brown quartz is valuable for the cabinet; many pieces, however, which appear to be of this colour, have only a deposit of oxide of iron upon the surface, removable by dilute hydrochloric acid. Quartz of a smoky tinge is often mistaken for beryl, but the latter has generally a peculiar horny yellowness as seen in the play of reflected light about the sides of the stone when held in certain directions. The beryl will, moreover, scratch quartz.

There is a beautiful stone which incloses minute fibres of asbestos, producing, when polished, a resemblance of flickering light, as seen in the cat's eye; this is only a fibrous variety of quartz, but is much prized. The difference between "cat's eye" and moonstone is simply this—the cat's eye has fibres in quartz, but the moonstone has them in felspar, which is a composition of quartz, alumina, and potash.

We often find the hollow flints lined with a pale bluish translucent substance, having what mineralogists call a "botryoidal" surface, like that of an aggregation of soap bubbles (or the surface of a bunch of grapes); this is chalcedony, and very handsome pieces are met with in shingle. Sometimes, in cavities, the chalcedony has in form much the appearance of icicles or a "stalactite." Layers of coloured chalcedony occur in

nature, and where such are straight or only slightly curved, the stone is called "onyx;" and in this figures are carved out of one layer, leaving another of a different colour as a background. Such carvings are the well-known "cameos." Stones in which an opaque white alternates with a deep or orange brown which is tolerably translucent, are called the "sarde onyx;" and in the estimation of the lapidary, the more translucency, the greater the value. "Sarde," itself, is a very beautiful and frequently met with variety of quartz, of an orange or amber yellow, or more commonly of a reddish yellow, and is only semi-translucent. Some specimens when moved in certain directions, possess in a considerable degree that beautiful play of light already referred to as *chatoyance*, and much resemble opals of the same colour, but are both heavier and harder. The richest shore for variety in this species of stone is the back of the Isle of Wight, from Niton to Bonchurch, although larger and elegant specimens of some sorts are obtainable between Walmer Castle and Sandown Castle, at Deal. What is known as "plasma" was formerly used in making ornaments; it is dark green, having lighter coloured spots. (Its specific gravity is only slightly above 2·0.) Bloodstone, or heliotrope, is a fine well-known variety of chalcedony, tinged green with chlorate, and has irregular dots and markings of bright blood-red jasper. A very pretty apple-green quartz is called chrysoprase; its colour is not uniform, but clouded, and the stone has considerable translucency.

The difference between chalcedony, carnelian, jasper, and agate, is often scarcely appreciable. The name carnelian was originally given to specimens of a flesh colour, but it is now extended to the brown and yellow varieties. Numbers are brought from the East Indies, but very beautiful specimens are found on the beach at Deal, and especially near Deal Castle, and opposite the dockyard. Carnelian is never figured nor striped; the deep, clear red is the most valuable for the purposes of the lapidary.

When layers of chalcedony, instead of being straight or nearly so (as in onyx) are suddenly interrupted by angles or sharp curves, the stone itself having some considerable translucency, such are termed agates, and many are of great beauty. They are never perfectly transparent. A general characteristic of agate in its rough state, is the resinous or waxy appearance of its fracture, while that of quartz resembles more the glitter of broken glass.

Scotch pebble is agate of an agreeable reddish tint, free from cloud or mark, and is semi-transparent. When without small flaws, to which it is very liable, it polishes into a handsome stone of good surface. When agate contains mossy or

branched internal markings, it is known as moss agate or mocha stone.

In some parts of England whole masses of agate rock are composed of layers of chalcedony or milk quartz in small but intricate convolutions; when these layers are of some dimensions and present angular flexures, they so much resemble the bastions of a fort, that the name "fortification" agate has been aptly applied to them. At St. Just, in Cornwall, this rock may be seen *in situ*.

The mixture of iron with flint or quartz gives it a considerable change in appearance, causing an opacity characterizing the bulk of fragments which form a shingle beach; and such is jasper. The prevailing colours are red and yellow, but it is also found of a deep rich brown, or even nearly black, and sometimes green. The bright pure yellow and the light scarlet are the most prized, although the latter seldom occurs except in small portions, but it is very elegant. Coloured layers are known as ribbon jasper; and when these layers are concentric, the stone is called Egyptian jasper, the yellow generally occupying the central portion of the stone. (All the varieties of quartz receive and retain a brilliant polish.)

A singular combination of quartz and water forms the "opal." A trace of water is detected in quartz, but in opal it amounts to as much as 10 per cent. Hence the lighter specific gravity of this mineral as compared with quartz, while its hardness is about that of window glass. The varieties of opal are sufficiently hard to be found among shingle. One is the "cacholong," of a milky white, and nearly transparent, distinguishable from milk quartz by its opacity and by its slightly adhering to the tongue. The "noble" opal is a very elegant gem, having colours combined in flashes of delicate lake, blue, and yellow. When the red greatly predominates it is termed "fire" opal. Common opal is abundant as fossil wood, and on some coasts may be procured in pieces of considerable size; it is easily detected by its showing the grain of wood, and being too hard to be scratched by a knife.

The only specimen of "felspar," besides the moonstone already mentioned as a constituent of granite, and worthy of present mention, as liable to occur in shingle, is the "Labradorite," a greyish or dull greenish stone, very slightly translucent, but when broken, and especially when polished, showing a pleasing iridescence. Like quartz, it takes a high polish.

The "smoke" beryl is found on almost all the south coasts of England, even so far round as Garrison Point, Sheerness. It slightly exceeds the quartz in hardness, otherwise it might easily be mistaken for opal.

This short summary of objects in shingle would be incom-

plete without mention of another subject, which requires the use of the pocket lens. For example, if we examine some localities we shall find rounded flints having perforations in various directions, not through the stone, but into it; on breaking some of these, the interest and curiosity are deeply attracted by the frequently found, perfectly well preserved and petrified remains of exquisite corals, sponges, etc. Indeed, the needle-like spicula of sponge are often in these nodules seen of the greatest conceivable delicacy.

Indescribably beautiful specimens of what the late Dr. Mantell called the "choanite," are obtainable in some beaches. If you find an oval, flattish stone with generally a rough exterior, having its roughness (on close examination) caused by minute, short curved lines, suspect the presence of the choanite; lay the stone in the hand (protected by a glove, handkerchief, or any soft body) and strike the specimen at the middle of the thinner and longer edge of the oval, with a small hammer. One or two smart taps will split the stone through its longest section and thus reveal the interior, the wetting of which will render it more plainly visible. There is no limit to the colour, and variety, and form of these beautiful fossil polypes. I believe Sandown Bay, in the Isle of Wight, to be the richest deposit in England of this remarkable class of objects; they are there met with in that beach of the size of three, four, or five inches in diameter.

DR. WALLICH'S AMŒBA VILLOSA.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopical Society of London.

My object is to lay before the readers of the Intellectual Observer some account of Dr. Wallich's *Amœba villosa*, a remarkable Rhizopod on which three papers have appeared in the *Annals of Natural History*, and which I have had some opportunities of examining myself. I hope that by thus directing the attention of a wide circle of microscopists to this curious creature it may be sought for in other localities, and its history still further explained.

In conformity with the view adopted in the notice of the "Protean Animalcules" in the Intellectual Observer for February of this year, Dr. Wallich expresses his belief that the *Amœbæ*, respectively named *princeps*, *diffluens*, and *radiosa*, are mere transitory phases of one and the same species, their dif-

ferences being of shape rather than structure. With the new form, which he designates *villosa*, the case is altered by the constant presence of a particular organ not found in the other kinds, and which marks a decided advance in specialization. The organ in question consists of a tuft of villi, capable of varying in length and breadth, but never disappearing except as an optical result of the position the creature may assume. The aspect of the *Amœba villosa* may be seen from the accompanying drawings, and those hitherto observed are mostly larger than the better known kind, some of them "attaining a diameter of not less than $\frac{1}{50}$ of an inch."

Dr. Wallich originally discovered this species in Lower Bengal in ferruginous pools, and when rambling over Hampstead Heath, behind Jack Straw's Castle, his attention was excited by numerous pools and puddles of a similar kind, the sediment in which disclosed the form of his old Indian acquaintance. The pools in question contain much flocculent matter, apparently of vegetable origin, strongly coloured by peroxide of iron. At some seasons they exhibit little animal life, and I had been so often disappointed with them that at the very time when Dr. Wallich was collecting his specimens, I warned some brother collectors that they were of no use. I mention this fact to show the necessity of never giving up any situation as hopeless, unless it has been tried under all varieties of season and weather.

When I read Dr. Wallich's first paper I expressed my desire to see the new creature, and he was so obliging as to show me some of his own specimens, and to give me a few from his then waning stock. In March he found them plentiful, in April less so, and by May they became exceedingly scarce, and soon disappeared. When plentiful they were associated with diatoms, chiefly pinnularia, and swarms of Crumenulæ and other coloured members of the Monad family. Fine specimens presented a beautiful appearance from being crammed full of these objects of food, which preserved their natural colours, and glistened with brilliant tints of emerald green, and various shades of orange, red, and brown. The voracity of the animals was extraordinary; there seemed no other limit to their appetite than the capacity of their whole bodies to take in and hold the miscellaneous subjects of their choice. Those which I saw were not very active, being, as Dr. Wallich explained, far less so than others which he had previously obtained. Without any noticeable structural change they grew languid, put out a multitude of small thin pseudopodia from various parts of their bodies, and finally died. When in better health their pseudopodia, as seen by me, were always broad, moderately long, and with blunt rounded tips.

The peculiar organs were either like a group of little fingers, or shrunk to slender dimensions. In the accompanying drawings they are represented almost as fine as cilia, which was often the case with my specimens, but they were very susceptible of enlargement and motion. At times I noticed a smooth rounded outflow of the so called ectosarc, or outer layer, not at all like pseudopodia, but transparent, free from granules or food particles, and similar in shape to the curved patterns which an advancing tide forms during a calm on a flat sandy shore. When this took place there was the appearance, but not as I imagine the reality, of a distinct and separate film dividing the food-holding and thicker portions of the animal from the thin outflow which I have described. Had the outflow continued and been resisted by the thicker part, a solution of continuity and rupture must soon have resulted; but when the tension of the expanded portion reached a certain pitch, it strongly compressed the thicker part, and then a current of sarcode carrying food particles flowed into it. Dr. Wallich, who devoted amazing patience to these creatures for many hours a day during three months, speaks of their having a motion of "reptation" or creeping, which my limited opportunities did not allow me to see distinctly, but the ordinary flowing mode of progression characteristic of the *Amœba* was often shown. Dr. Wallich likewise noticed that the villous organ was sometimes employed as an instrument of prehension; and it was remarkable in his specimens and in mine that no important pseudopodia were projected either from the villous patch or from the sarcode in its immediate vicinity. I often saw *small* pseudopodia in its neighbourhood, but they were insignificant both in size and in any use the creature made of them.

For want of sufficient specimens I could not obtain opportunities of getting drawings of the nucleus and contractile vesicle, although I occasionally caught a glimpse of them. It was very easy in many specimens to mistake some round objects of food for the nucleus, but Dr. Wallich was so fortunate as to observe and draw many nuclear bodies in a mulberry condition, and to examine them, after their extrusion from the animal. The villous patch is capable of being thrust forth from the general mass upon an elongated pedicle, and it is in some way curiously connected with, or acted upon simultaneously, with the nucleus and vesicle. Dr. Wallich says,* "I have had ample opportunity of verifying the observation that in the majority of specimens, so long as the villous patch is being employed as an organ of prehension, and not merely dragged along in rear of the main body, the nucleus and contractile

* *Annals Nat. Hist.*, April, 1863.

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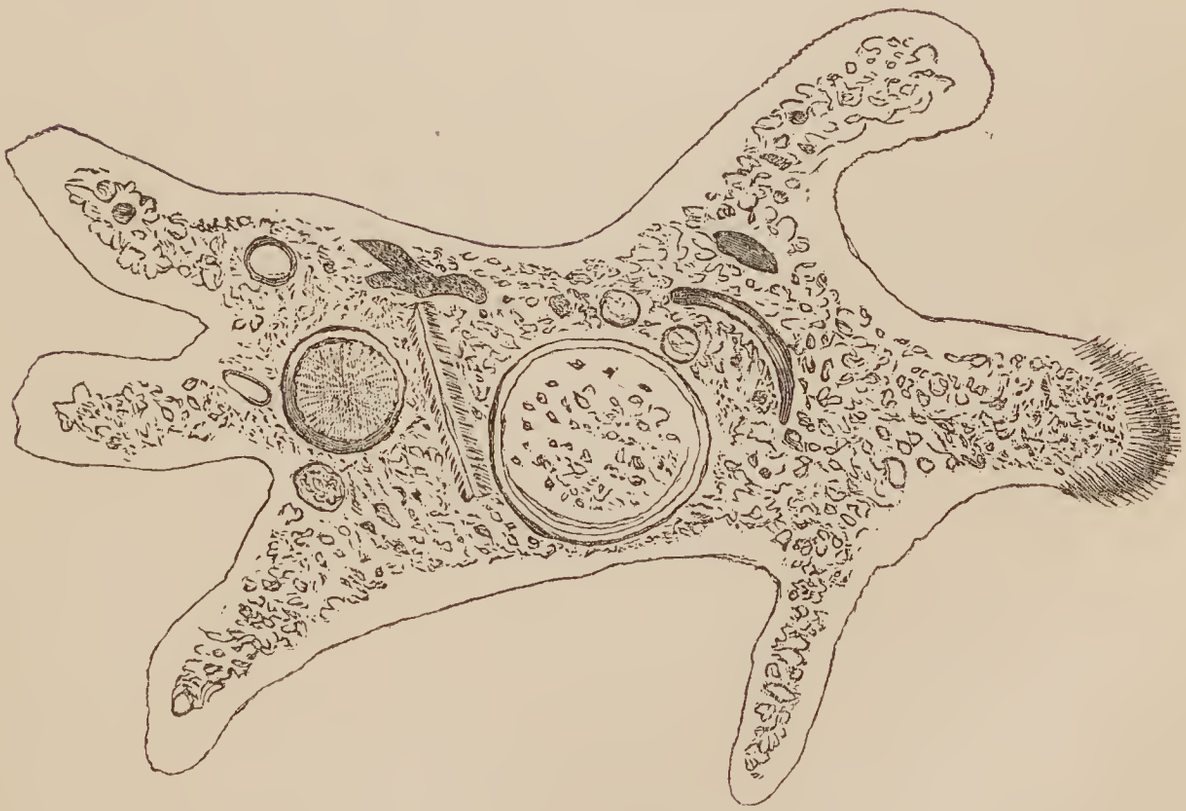
AMŒBA VILLOSA.



vesicle retain their position in its vicinity, but that they circulate with the other contained matters whenever the prehensile action of the villi is in abeyance." From his various observations it would appear that there exists "some kind of consentaneous action between the contractile vesicle, the nucleus, and the villous area." In a few instances he saw a delicate tubule perforating the villous patch, through which minute particles were ejected. The ordinary progress of the creature is *from* the villous patch *forward*, so the villous organ is dragged behind. In my specimens it was often temporarily obscured by an overflow of the adjacent sarcode.

Another important characteristic which I had no means of observing, is thus described by Dr. Wallich, who says, "One of the most remarkable amongst the novel and varied characters of these *Amœbæ* consists in the vesicle in which the true nucleus is contained, having been found to be distinctly membranous in mere individuals." This fact the Doctor verified by examining nuclei isolated from the main body by means of the compressorium. This observation relates to single separate nuclei, and he adds, "In contradistinction to this the multiple nuclei had neither inverting membrane nor nucleolus. Can it be that the one phase represents the germ cell and the other the sperm cells?"*

A very important question raised by Dr. Wallich relates the distinction which has been made between the ectosarc and endosarc in these creatures. In one of the papers referred to† he came to the conclusion that "the ectosarc and endosarc are not permanent portions of the Protean structure, but mutually convertible one into the other, and that it is an essential feature of sarcode that whilst the outer layer becomes, *ipso facto*, instantly differentiated into ectosarc, the same layer reverts to the condition of endosarc under the circumstances just described;" "these circumstances" being "the projection of the ectosarc from the general surface, in the form of a hemispherical mass, with a broad base, only a very small portion of the original contour line seeming to give way at first, so as to admit of the passage of the endosarc and other granular contents into the newly projected part, but its entire floor appearing to be gradually dissolved, as it were, and free communication between the main body and the new pseudopodial cavity not being established until the completion of this process." This theory has a high degree of probability about it, and if confirmed must modify the ideas entertained concerning the differentiation exhibited in ordinary *Amœbæ*. Experiments with reagents are very liable to the misconstruction arising from the difficulty of distinguishing between what they reveal and

* *Annals Nat. Hist.*, May, 1863. † Ibid.

what they make, and it is conceivable that a substance like sarcode should exhibit different properties when in contact with water containing air, to those which it possesses when all its particles are secluded from direct contact with water, but are bathed by the internal fluids of the creature, and surrounded on all sides by other particles in precisely the same state. Dr. Wallich does not, however, consider that the villous patch is permanent in its condition; on the contrary, he conceives that a slow and constant interchange of protoplasmic matter takes place there as in other portions of the body. He regards the *Amœba villosa* "as bridging over the hiatus between the true Rhizopod and true infusorial organization." The principal distinction of the latter consisting in possessing distinct organs for the inception and extension of foreign matter, and in there being "no convertibility of parts once established."

Dr. Wallich also considers that he has established with regard to these *Amœbæ* the fact of viviparous reproduction, the young ones being from $\frac{1}{2,500}$th to $\frac{1}{1,600}$th of an inch long, and exhibiting nucleus, villous tuft, and contractile vesicle. I should add that he found in several specimens extremely minute crystals of rhomboidal figure, and soluble in muriatic acid.

In conclusion, I may state that my specimens of the *Amœba villosa* were very uneven in surface, from the multitude of objects that had been taken in by the gelatinous mass, but were not sufficiently engulphed to leave it smooth. That a creature of such low organization should range from Bengal to Hampstead will excite no surprise, but it would be interesting to ascertain whether the presence of oxide of iron is necessary to its existence, or, in other words, whether it is confined to ferruginous pools, which may be its exclusive habitation, although their colouring matter did not impart the slightest tinge to those which I saw.*

* Since writing the above, I learn from Dr. Wallich that he has found the *A. villosa* at Streatham. Hs adds that he is more and more satisfied that all the different forms of *Amœbæ* are transitional phases of one and the same organism, of which the *A. villosa* is the highest state of development.

WHAT IS INSTINCT?

BY SHIRLEY HIBBERD.

M. Flourens has added to the long list of books bearing his name one on Instinct and Intelligence,* in which he reviews with some care the opinions of all the great authors who have written on the subject, and supplements those opinions with suggestions and deductions of his own. We cannot award M. Flourens any high praise, either for originality or profundity, but we would be content to gather from his pages any useful items of information, and thank him for obtruding upon our attention a most interesting subject, could we do so without suffering the vexation of seeing logic superseded by sophistry, and truth made the slave of human pride. But M. Flourens follows very faithfully the example set him by the authors he reviews. It is perhaps a hazardous proceeding to utter a general condemnation, but we fear it is but too true that the only honest writers on this subject are those who take the most ridiculous views of animal instinct and intelligence. For instance, Descartes in his *Discours sur la Méthode*, denies animals the power of thought, on the ground that they do not possess the faculty of speech. He says, "Although beasts do many things as well, and perhaps better than one of us, they infallibly fail in many others," by which, he says, it may be inferred that "they do not act from knowledge, but only by the disposition of their organs." "It is a remarkable thing," he says, "that there is no man so stupid, excepting only the insane, who are not capable of arranging together divers words and composing a discourse; but, on the contrary, there is no other animal, however perfect, that can do the like, and this not only proves that beasts have less reason than man, but that they have none at all."

Buffon is equally honest, and almost as absurd. He admits that brutes have sense and feeling, and also that they have a consciousness of their actual existence, *but not of their past existence;* they have sensations, but no power to produce ideas. Upon these grounds Buffon denies that animals are capable of thought, reflection, and memory, yet he avoids the extreme view of Descartes, that they are merely vitalized automata. "Condillac is right," says M. Flourens (p. 41), "when he says if beasts invent less than we, if they perfect less, it is not that they fail entirely in intelligence, but that their intelligence is

* *De l'Instinct et de l'Intelligence des Animaux.* Par P. Flourens. Paris Garnier Frères, 6, Rue de Saint-Pères.

more limited. But he is wrong when he says that is, by a sort of invention, that is to say, because he *compares, judges,* and *discovers* that the beaver builds his cabin, or the bird constructs his nest, and therefore all his theory upon the faculties of animals is vicious, because he confounds the things which are essentially distinct, namely *instinct* and *intelligence.*" The most entertaining of all the disquisitions on this subject is undoubtedly that by Lord Brougham, in the *Dialogues on Instinct,* wherein he takes care to put down all the sage remarks to his own credit, and makes Lord Spencer responsible for statements most easily refuted. In this delightful book numerous examples of (so called) instinctive operations are described and analyzed; but in spite of the noble author's manifest desire to be liberal and just, it is but too evident he is influenced by what Smellie, in the fifth chapter of his *Philosophy of Natural History,* designates "mistaken notions concerning the dignity of human nature." To sum up this bibliographic note, without reference to many less distinctive opinions, we must notice two other attempts to solve the riddle of instinct, if only for the purpose of showing what opposite opinions may be entertained of the same subject. Father Bougeant, a learned Jesuit, in a tract called *A Philosophical Amusement Concerning the Language of Birds and Beasts,* affirms boldly that animals are capable of thought and reflection, and to escape all the difficulties arising out of "mistaken notions concerning the dignity of human nature," contends that the actions of animals are entirely the result of the influence of evil spirits, that in fact the brute creation is under the dominion of the devil. On the other hand the great Newton considered that all animals were under the immediate operation of the Deity, and that consequently their instinctive and intelligent actions were alike the expressions of divine impulses.

The definition of instinct commonly subscribed to is that it is a blind impulse, that it acts without knowledge either of the means employed or the effect to be produced. With all their professions of dissent from Descartes, the majority of definers, with Lord Brougham for leader, have concurred in his opinion that animals are like clocks, the Creator has wound them up, and they must continue as long as their races last, accurately, unchangeably, and ignorantly, in the course of action first appointed them. Brougham classes instincts as physical and mental. Physical instinct, he says, is independent of mind altogether, and mental instinct is independent of reason altogether. The example generally chosen is unquestionably the most difficult, no matter what prejudice we lean to, or however perfect may be our freedom from bias of every kind. We are called to examine the work of the honey bee. Here are hexa-

gonal cells, which afford a maximum of strength, and consume a minimum of material. They terminate in rhombic dodecahedrons, they incline at an uniform angle, so that the liquid they are constructed to hold shall not escape, and they are arranged in the hive so that between every double set of cells there is sufficient space for traffic between them. There can be no dispute as to the general accuracy of the work, and as to the fitting together by proper relationships of all the events and operations incidental to the life and industry of the hive. But we may reasonably dispute the fairness of instancing the work of the bee as an example of blind, untaught, objectless instinct; for this simple reason, that all the evidence for such a view is of a negative character. Brougham sums up the matter thus:—"Laying aside those actions of animals which *show a glimmering of reason,* and confining ourselves to what are purely instinctive, as the bee forming a hexagon without knowing what it is, or why she forms it, my proof of this not being reason, but something else, and something not only differing from reason in degree but in kind, is from a comparison of the facts, in a word, from induction. I perceive a certain thing done by this insect, without any instruction, which we could not do without much instruction. I see her working most accurately without any experience, in that which we could only be able to do by the expertness gathered from much experience. I see her doing certain things which are manifestly to produce an effect she can know nothing about, for example, making a cell and furnishing it with carpets, and with liquid, fit to hold and to cherish safely a tender grub, she never having seen a grub, and knowing nothing of course about grubs, or that any grub is ever to come, or that any such use, perhaps any use at all, is ever to be made of the work she is about. * * * In all this she differs from man, who only works well, perhaps at all, after being taught; who works with knowledge of what he is about, and who works intending and meaning, and in a word designing to do what he accomplishes. To all this may be added, though it is rather perhaps the consequence of this difference than a separate and substantive head of diversity, the animal works uniformly and alike, and all his kind work alike; whereas no two men work alike, nor any man always, nay, any two times alike. Of all this I cannot indeed be quite certain, as I am of what passes within my own mind, because it is barely possible that the insect *may have some plan or notion in her head, implanted as the intelligent faculties are;* all I know is, the extreme improbability of it being so." Now although this theory of instinct has been generally assented to, we do not hesitate to challenge it, in the belief that we shall be able to prove that it is of the

same species of sophistication as the quibble of Zeno, that a man cannot walk a mile.

First, we will submit it to a test which may always be applied with fairness, that is, we will apply the author's conclusions a little more extensively than he has done himself. The bee makes a hexagon without knowing what a hexagon is, or what it is for, though she herself is to fill it with honey or pollen, and seal it up when filled. Ergo, the bee visits a flower without knowing it is a flower, she extracts honey without knowing it is honey, or that honey is her proper food. She flies through the air to some distant place without any expectation of finding there the flowers that yield honey, and she goes to a place she has much frequented, and which abounds with flowers which yield honey plentifully, without knowing she has been there before, and in fact without intending to go at all, and without any idea of what she will do when she reaches her destination. She returns to the spot she started from without knowing that it is the spot, or that she is a member of a community, or that her interests are identified with the bees composing that community, or that there is a community or any such thing as another bee in the world besides herself. Indeed, we do not see that she need know even of her own existence, if she is so fatefully mechanical as to build and furnish a cell without knowledge of what it is, or any forecast of its future uses. If we accept the first hypothesis, we cannot refuse the second; if we invent premises, we must follow them to their ultimate consequences. It is not long since we heard a schoolmaster argue thus:—"Brutes have no soul, therefore they cannot reason. The elephant is a brute, therefore it is only a vitalized machine; it cannot reason."* We can scarcely avoid classing the excercitations of Lord Brougham with those of our syllogistic friend; in fact, of the two we prefer the latter, because the sophistry is delightfully apparent.

Now as to the proofs. Who can say that the bee does not know why she forms a hexagon? When we observe that bees quickly select the best honey-producing flowers, as, for instance, mignonette, spergula, bramble, Dutch clover, salvia, nemoralis, etc., etc., to the neglect of others which furnish little honey, we applaud their sagacity, and say nothing about blind impulse. We know of no impulse to direct bees to lime trees in such numbers that their humming oftentimes alarms the passer-by, nor do we know how mere instinct should cause

* The person whose words are quoted above enjoys an enviable fame as a trainer, and has been most successful in his vocation; that is, measuring success by the number of his pupils. It would be cruel in this connection to publish his name.

them to neglect the garden, when they have choice of the more odoriferous flowers of the moorland. She is allowed to know what honey is, and to distinguish between good and bad honey; she is granted the faculty of distinguishing a rose from a cabbage, and the bee master from an intruder, of detecting a robber bee upon the threshold, and of recognizing the presence or absence of the mother of the hive; but when her work intrudes upon the domain of mathematics, we are startled from our propriety, and at once forget our former conclusions of the capacity of the bee to observe, remember, and reflect, and suddenly insist that she is doing something in utter ignorance of what she is doing, or that she is doing anything at all. The researches of Maraldi and Torre on the work of the bee have literally nothing to do with the question of instinct, for it cannot be contended that because the work of the bee is mathematically perfect, that therefore she must be as ignorant of her own work as a clock is that it is recording the true time.

"I see her working without any experience," says Brougham. It is a gratuitous assumption that the bee has no experience. It is quite possible that bees inherit experience as man does, for it must be remembered there is an experience of the race as well as an experience of the individual. But let us look at the facts. Dr. Bevan and other authorities concur in the opinion that the worker bee lives from six to eight months. Mr. Taylor, the author of the best book on bees, adopts this view. In the course of twenty-one days from the laying of an egg by the queen bee, the egg has been hatched, and the worm has completed its last metamorphosis. An individual bee, therefore, may witness the birth of *nine or ten* successive generations of workers in the course of its lifetime, and transmit the experience gained thereby to those successive generations by a process of teaching. But putting aside the possibility of teaching, here, at least, is experience, which it is so essential to deny on the theory of instinct being a blind, objectless impulse. But this is not all. Mr. Desborough, of Stamford, set himself to work out a solution to the question, how long does the queen bee live? and the writer of this saw all the apparatus used by Mr. Desborough, and believes in the soundness of the conclusion arrived at, that the same queen continues active and fertile during a period of *four years* at least; how much longer she endures Mr. Desborough was unable to ascertain with certainty. It is surely as reasonable to conclude that the experiences of bees are of use to the community as the experiences of men, and seeing that they have abundant opportunity for acquiring experience, we prefer to believe that they work by knowledge rather than adopt a theory which derives no support from observation.

It is equally an assumption that the bee works uniformly, as it is almost a falsity to say that men work diversely. If a hexagon fulfils the conditions of a given case, and there is no other form that will fulfil those conditions, then there must be a hexagon whether the worker be bee or man. A broad view of human affairs will show that man is as much the slave of impulses and blind instincts as the bee, if we are to admit impulses and instincts at all as separate from actual knowledge. The philologist tells us that all languages are easily reducible to a few elementary forms. The ethnologists say that there is very little diversity in the fashion of human habitations, and our present experiences tell us that in all our works of art we draw upon the past, and are much more occupied in repeating what has been done than in inventing things unattempted yet! Even in the domain of literature there are but few primary ideas: all the Greek epics and tragedies were framed out of the same half-dozen stories, and at the present day there is no nobler form of verse known than that in which Homer sang. Granted that men do work diversely, though to a much less extent than is generally supposed, so does the bee. A newly-hived swarm works with more vigour than the population of a well-stocked hive. If the work of the bee be interrupted, there is an immediate adaptation to the new circumstances of the case, and when a disaster happens there is a speedy resort to new methods of procedure, either to avert its worst consequences or to repair the damage the community has sustained. As to the alleged perfection of the works of the so-called blind instinct, that is the most gratuitous assumption of all. The work is not uniformly perfect, but frequently very imperfect, and in this respect exactly parallel to the occasional aberrations of acknowledged intelligence. For instance, bees will sometimes collect pollen in such prodigious quantities as to prejudice their own well-doing, and lack honey for their own use while heaping up bread superfluously for a small progeny of young. What becomes of the theory of instinctive perfection in the face of such a fact as this? Yet it is very like the occasional mistakes of men, as when a ship laden with leather boots puts into a port where the people are starving for want of bread, or, as in the case of the Crimean war, green coffee was sent to men who had neither fires to roast nor mills to grind it. Were the instincts of bees so perfect as they are represented, we should never witness examples of the queen dropping eggs at random, because there are no cells to receive them, nor should we see in honey boxes that the first combs were often so badly placed that in the end the bees had to fill up odd nooks and corners with twisted and triangular patches, which are at any time significant comments on the theory of instinct infallibility. Pro-

bably Lord Brougham and many other learned writers on instinct never had to shift a few stocks of bees from one place to another in a garden, or to hive swarms, or take boxes of honey, else we might have heard much less about the alleged uniformity of procedure and invariable perfection of results. What is the instinct which prompts bees to a savage exercise of their powers to wound and poison when molested?—do they not know what they are doing? and have they no object in pouncing on the marauder? If they sting the man who takes the harvest so carelessly that they discover the trick before it has succeeded, is it not fair to conclude that they know they are being robbed, and avail themselves of the means of punishment with which nature has furnished them?

We have argued this case on the basis of the mathematical theory of bee economy. Respecting this theory, there are two things to be said. First, it is not true; secondly, it demands so much of the bee that it compels the adoption of a false theory of instinct. Error and folly are boon companions; the supposed mathematical accuracy of the angles of cells required us to believe that the bee had learnt, without teaching, what a large proportion of human beings could not learn with teaching, or to account for the whole affair by supposing the insect to be under a mysterious power, the attempt to define which made it more mysterious. Notwithstanding Brougham's remark, that "there is no bee in the world that ever made cylindrical cells," it is very certain that the bee makes nothing else, and that hexagons and rhomboids are alike the result of pressure, and represent the angles of equilibrium between the pressure and the resistance, just as the orbits of the planets are the midway lines between centrifugal and centripetal forces. The insect is not such a mathematician as has been generally supposed, and, therefore, when it is demanded for bees that they know somewhat of the nature of their work and its intended uses, all that is asked is to allow them as much intelligence as is needful for the construction of simple cylinders of the same size as their own bodies. It is true we have not now accounted for the fact of their working to a common plane, or for the ordinary disposition of cells on either side of that plane, by which a double comb is produced. These certainly appear to be instinctive operations, but they are of that kind which Brougham admits "show a glimmering of reason," and if there be a glimmering anywhere, we know for a certainty that there somewhere near at hand light is to be found. In the *Annals of Natural History*, of June, 1863, will be found an analysis of the mathematics of the beehive, by the Rev. S. Houghton, in which the theory of the bee forming hexagonal cells is completely overthrown. We owe it to our friend Mr. W. B. Tegetmeier that we were long ago

convinced that bees make cylindrical cells, and as we have seen those cells in formation and can generally find some in the outer portions of removed comb, there is no other course left us but to ascribe to the laws which control inanimate matter the mathematical wonders which have been made the basis of a sophistical theory of instinct.

We have spoken decisively as to the utter ignorance of the bee in mathematics, and the difficulty of the hexagonal cells is annihilated. We have room to say that the alleged economy of material is as great a delusion as the other. We owe it to Mr. Houghton that our attention has been called to the investigation by mathematicians of the relation of expenditure of material to the mathematical requirements of connected cells of given dimensions, and of a form adapted to the uses to which they are to be put. L'Hullier, in 1781, using MacLaurin's method, arrived at the conclusion that the economy of wax referred to the total expenditure is $\frac{1}{5}\frac{1}{1}$st, so that the bees can make fifty-one cells instead of fifty, by the adoption of the rhombic dodecahedron. But L'Hullier maintains that mathematicians can make cells of the same form as those of the bees, which, instead of using only a *minimum* of wax, would use the *minimum minimorum*, so that five cells could be made of less wax than that which now makes only four, instead of fifty-one out of fifty. But suppose, again, that we grant the alleged economy of wax, we only get out of one difficulty for a moment to encounter a greater, the moment the theory of a mathematical instinct has been propounded for general purposes. Say the hive bee has attained to perfection in her work, what, then, of the humble bee? Is she to be shut out from a participation in this wonderful instinct, or shall we grant her the higher faculty of reason, and so account for her abuse of the laws of geometry, as we see in humble bees of the human race, who frequently waste timber, stone, and other materials, through ignorance of leverage and the nature of strain in constructive operations? Certain it is that the humble bee uses, proportionately, more than three times the amount of material in the construction of cells than is used by the hive bee; and if the hive bee is so far from attaining to the ultimate possibility of perfection in the economy of wax, how should the humble bee excite our pity and give occasion for the theorists to lament that facts are against them! Nature has not commissioned these insects to teach men mathematics, nor has she commissioned men to deny them a share of the same intelligence which, in human affairs, vindicates its existence in a great measure by its errors.

But this will suffice, perhaps, for the present about bees. We have said so much only because this is the favourite example

of the theorists who contend for a mental instinct, and limit it by boundaries furnished out of their own imaginations. M. Flourens institutes a categorical inquiry into all the mental qualities of animals, and, up to a certain point, very satisfactorily. Let us, adhering to his method only as far as may be convenient, glance at some of these qualities as we see them manifested. It is admitted, even by the automatists, that animals have a consciousness of their existence, but then they say they have no power of thought. "How," asks Flourens, "can they have consciousness without knowledge, and knowledge without thought?" What is consciousness but knowledge, and what is knowledge but retained impressions and ideas? "They have *no memory*. What! this dog, which *distinguishes*, that is to say, *recognizes* the places he has lived in, the streets in which he has run; who has been corrected by chastisements, who seeks for the master he has lost, who goes and dies upon his tomb,—this dog has *no memory!*" It is a smart jump from the bee to the dog, and it is a jump we make, and not M. Flourens. But when we are confined to a brief summary of arguments, extreme cases are best, and the bee offers an example of the extreme one way and the dog the other. Now let us compare them. They have no speech, says Descartes, and there are foolish people of the present day who join with him. Then the whine of a dog at the door on a cold night does not imply that he wishes to be let in. The deep bay of the mastiff when there is a sound of a strange footstep at night is not to be understood either as a warning to the master, or a threat to the thief, or an expression of the dog's suspicion that all is not right, it is only a fortuitous sound, the result of purely physical causes, and may rank with any of the sounds produced by inanimate nature. But perhaps there will be no dispute as to the speech of the dog; but it will be asked has the bee speech also? We answer *yes*. The writer of this has had bees under his observation daily for a period of over fifteen years, and could bring forward examples to illustrate every requirement of a theory of insect intelligence were it needful, and would space permit. But one instance will suffice. A bee, whom we will call A, is entangled in a spider's web; he has been liberated and placed on the floor-board in front of the hive. Another bee, whom we will call B, approaches, and exchanges with the victim of Arachne a few passes of the antennæ. B immediately enters the hive, and presently returns with two others, C and D. B, C, and D then commence cleaning A of his entanglements, and in so doing get somewhat entangled themselves with the glutinous threads. Every now and then there is a pause, and all of them engage in bringing their antennæ into mutual contact, and occasionally after one of these conferences, a new

method of cleaning is tried; and the end of it is, that the object of their solicitude, A, is at last purified of his spidery pollutions, and all enter the hive together, and we see no more of them. The observer concludes that they made communications to each other on the subject of A's troubles, and by mutual agreement determined on his release from bonds, and the cleansing of their own persons of the defilements he had unavoidably fastened upon them. If a man were entangled with ropes, and his comrades consulted how to release him, and eventually succeeded, we should not describe the act as the working of a blind impulse, or of an instinct which neither knew what it was doing, nor what was the object of its labours; why then should we degrade the bee by denying that she has knowledge, or attempt to prove her deficiency of knowledge by hazarding the assertion that she is incapable of speech?

What is Instinct? We could not attempt to answer this question until we had first done something towards clearing away the absurdities of theorists who trusted more to syllogisms than to observation, and to fancy rather than to fact. What are called physical instincts are no doubt very often, but not always, "independent of will or mind altogether." About these we will not raise a question. But mental instincts appear to be of the same nature as reason, directed with intensity in a narrow channel. It is an instinct of the bee to collect honey. We must grant that it knows what honey is, and what honey is for, and by so far the act of collecting is the act of reason. But it is pursued with such ardour, that it becomes the fixed habit of the insect, and a habit may be followed so mechanically, that it may on a superficial view appear to be but a blind impulse, and to be performed without knowledge. But no matter how strong the force of habit, if, initially, it is the result of an act of reasoning and the expression of a *motive*, and is followed for *a purpose*, then it can never be separated from mind; though when the habit is fixed, it makes little or no demand upon the mind until some exigency arises demanding a deviation from habitual rule. Let the reader reflect upon any habit of his own, as that of reading without noticing the individual letters of words, without thinking at all of the rules of punctuation and pronunciation, without perceiving at all the minute relationships of words to each other, and occupying the mind only in following the thoughts of the author, and the act of reading will appear to be purely instinctive. Yet we know it is not, and have never considered that men were machines simply because of their capacity for literary pleasures. Test the comparison by reference to any other act which is performed habitually, as the motion of the foot in turning the lathe when the mind is wholly directed to the action of the cutters, and

how much like what we call instinct in animals is the effect of habit in ourselves. How the bee first acquired the art of extracting honey from flowers, and building comb from wax, we know not; the inquiry into that matter must have its place in the general inquiry as to the beginnings of all things; but we much rather believe that her work is the result of intelligence and performed with knowledge, and capable, up to a certain point, of improvement by experience, and, in a word, the result of reason modified by habit, than an ignorant and, so far as she is concerned, purposeless endeavour to accomplish an end which she neither foresees nor has any care about.

It may be said that after all we have only exchanged one word for another. Such is not the case. We have no objection whatever to the employment of the word Instinct, provided it be no longer considered as something independent of mind. We would rather regard it as the proof of mind, and as something impossible, except as a mental product, or, as we have said above, the work of mind rendered tolerably uniform by habit. Let us illustrate this.

Every distinct breed of dogs has peculiar instincts. A thorough-bred shepherd's dog will take to sheep with scarcely any teaching, but a dog of any other breed will require very careful training to be able to take care of sheep, and then be but a bad sheep dog. The instinct to protect sheep is initial in the individual sheep dog; but if all dogs are from the same stock, it must be a habit transmitted, not an aboriginal instinct. In fact, so far as we understand the dog, its pure instinct would lead it always to worry and never to protect sheep. There is no breed of dogs that will follow game by scent with the steadiness of the hound; but if the following be an instinct, why is the pointer deficient of it? The answer seems to be, that in the first instance the hound has been taught, his mind has been informed, and the knowledge gained thereby is transmitted to his offspring, just as Sir John Herschel has inherited from his father a taste for astronomy, and has followed it by the light of reason and not by the light of instinct. Terriers and spaniels will hunt by scent, but they will not *pack* as hounds will, and hounds undoubtedly pack because they run at large game, and one individual would be insufficient to cope with it. A well-bred pointer will point at game the first time he sees it, and need scarcely any teaching beyond such as is necessary for obedience to calls and such like minutiæ. Sir John Sebright, in his *Observations upon Instinct*,* expresses an opinion that "the greater part of the propensities that are generally supposed to be instinctive, are not implanted in animals by nature, but that they are the

* Published by Gossling and Egley, New Bond Street, 1836.

result of long experience, acquired and accumulated through many generations, so as in the course of time to assume the character of instinct." Whether we accept this opinion as sound, or reject it altogether, we must tacitly consent to it whenever it is our object to produce a breed of animals required for any active purpose; and in dogs especially the breeder will prefer cleverness before beauty, and in choosing a sire ask first about his performances, in the full expectation of a progeny capable of exhibiting superior ability.

All our knowledge is relative, and it is therefore vain to seek for a perfect theory of the intellectual powers or a definition of instinct utterly unassailable. But it is not difficult to perceive, that in harmony with the development of form, so is the development of mind—there is least of both in zoophytes and insects, and most of both in man. But it is a violation of the law of harmony in creation to consider the mind of the brute as in any way different in kind from the mind of man. The difference is in degree only, and in man we find all the powers of all animals combined, instincts included, some scarcely discernible, others prominent in his character; but they are all there, and it is this combination that gives him command of all the elements as the master of the world. We may seek in man for illustrations of all the mental and physical qualities of animals, and perhaps do better by reasoning upon facts associated with experience, than upon facts removed from the range of experience. Thus, instead of inquiring what is the nature of purely physical instincts in brutes, let us ask what is their nature in man. The beating of the heart, and the peristaltic motion of the intestines, are called physical instincts; they are performed involuntarily, and are ordinarily independent of the will. But what is the act of swallowing? It is a voluntary act, yet for the most part it is performed without a thought; and while engaged in an animated conversation at the dinner table, we swallow without knowing it, and sometimes without having knowingly experienced any sensation of pain or pleasure from the flavour of the food which has been passed to the stomach. A deliberate act of deglutition is certainly the result of mind in action—the will is operative, and we know what we do, and why we do it; but an unconscious act of swallowing is instinctive, and the first act of swallowing by a newly-born infant just put to the breast is an instinctive action. Without certain of these aboriginal instincts, animal life would be impossible; but their range is limited, and they are all physical in their nature, and it is manifestly erroneous to class them with actions that imply choice, and that are evidently the result of some kind of calculation based upon experience. Whenever the action is

elective and conditional we assume the existence of mind, and see signs of its activity. From such instances as these we may trace the gradations upward to the highest attainments of reason, but we must never forget that we are tracing a gradation and not passing from one category to another, from one kind of reason to another kind of reason, any more than we would dare to assert that there are two kinds of matter, knowing, as we do, there is but one.

Through not keeping these principles in view, M. Flourens has gone quite astray from the truth in his amusing but superficial essay. He says, "the cry of an animal can reveal an idea, but is not the produce of an idea;" as if he had for some time lodged in the brain of a brute, and had satisfied himself of its destitution of ideas. "Animals," he says, "have no language, their cries are not known signs, they have their natural voice, but they have no speech," as if for the purpose of communicating information and ideas by vocal sounds, which from everyday experience we know they do, it were necessary for them to frame grammars and write epics. "Reflection well defined," he says, "is the knowledge of thought by thought. And this power of thought upon thought gives us all an order of new relations. As soon as the spirit sees, it judges; as soon as it can act by itself, it is free; as soon as it is free, it becomes moral. Man is only moral because he is free. The animal follows the body; in the midst of this body, which is enveloped in matter, the human mind is free, and so free that it can, when it wishes, even immolate the body itself." We have a parrot which occasionally sings—

> "I am perfectly free
> To climb up a tree,
> But I can't get out of my cage."

We fancy M. Flourens, with all the freedom he accords to man, is himself very much in the condition of our parrot.

ASTRONOMICAL NOTES.

DOUBLE STARS (*Concluded*).—PARALLAX OF MINUTE STARS.—QUADRATURE OF VENUS.—TRANSITS OF JUPITER'S SATELLITES.—OCCULTATIONS.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

DOUBLE STARS.

In this, which will form the concluding portion of our list of the more conspicuous binary and double stars, will be comprised a number of objects which, with few exceptions, are not conveniently visible at the present time, but which, having been omitted at their proper season for want of room, have formed a gradual accumulation. From the peculiarly unfavourable nature of the skies of last year, and from the interruptions occasioned by moonlight, there is little doubt that the objects enumerated in former papers can have been but partially recognized by the student. He will, therefore, have on hand a considerable *residuum* of his own, to which the greater part of the following list may be considered an addition, and the whole reserved for future opportunities.

We begin with a very beautiful and interesting pair of thoroughly-established binary character. A line drawn through α and β *Ursæ Majoris* (the *Pointers*) towards the S. will pass nearly through ψ, a 3-mag. star, and, if continued, will direct the eye to two 4-mag. stars near together: the furthest or southernmost of these is our object—

106. ξ *Ursæ Majoris.* 1″·8. 207°·5 (1830·94). 2″·9. 123°·5 (1851·31). 4 and 5½. Subdued white and greyish white. The great change thus indicated in little more than 20 years is brought down to 1857·357 by Secchi, the mean of whose measures is 3″·111 and 109°·74. This very fine binary system possesses a peculiar interest from the fact that it was the first whose orbit was ascertained from calculation. Sir J. Herschel had recommended especial attention to it in 1825, but Savary, a French mathematician, who died young, published, in 1830, the first elements of an ellipse computed by a method of his own from the previous observations, beginning with 1782, and inferred a period of 58¼ years. This, though not entirely confirmed by subsequent measures, was an approximation deserving of great praise, for Herschel has given 59 and 61 years, Smyth 65 and 60, and Mädler and Villarceau have very nearly agreed upon a period of 61½ years. There have been many unexplained discordances, but since considerably more than a whole rotation has been accomplished since its first discovery, there can be no question as to the broad fact that these two beautiful

suns are revolving round each other in a period actually shorter than that of the planet Uranus. In addition to this they possess a considerable amount of combined proper motion.

Reverting to *α Persei* (Int. Obs. XI. 374), about halfway from that star to ε (the nearest star) in *Cassiopea,* we come to—

107. *η Persei.* 28″·4. 300°·4. 5 and 8½. Reddish yellow and blue; a minute and elegant object. On reviewing this star during the present season, I found that it was surrounded by that peculiar crimson glare, or fringe of more intensely-coloured light, which has been already referred to in the case of λ *Herculis* under No. 39 (Int. Obs. VIII. 136). More careful examination, however, convinced me that the appearance was a deceptive one, arising from the eye-piece having been pushed in beyond the correct focus; and, since I found that such a border could be thus produced at pleasure, I have felt doubtful whether the supposed phenomenon has in any instance a real existence.

108. *ε Persei.* 8″·4. 9°·1. 3½ and 9. Pale white and lilac. Stationary. 1849·84, I thought the companion very small for its assigned magnitude. A month later, Mr. Hind, with the late Mr. Bishop's large achromatic, was of the same opinion; and I have renewed my impression this spring. Dembowski, however, in 1855, made it 8 mag. of W. Struve's scale, which would not differ much from Smyth's estimate. It is to be found on the edge of the galaxy, nearly equidistant from *α* Persei and the *Pleiades,* but considerably to the E. of the line which joins them.

Nearly in a line from this star to the *Pleiades,* and about halfway, we meet with—

109. *ζ Persei.* This interesting and elegant group is quadruple, at 13″·2, 82″·9, and 121″, with corresponding angles of 206°·6, 198°·1, and 185°; the magnitudes being 3½, 10, 12, and 11, and the colours flushed white, smalt blue, ash-coloured, and blue. The nearest star seems the faintest, unless care is taken to exclude or allow for the overpowering light of its large neighbour. Herschel II., Dawes, and Knott have seen a 5th star, still more minute, which is not mentioned by W. Struve or Smyth. Knott's measures, 1860·84, give 33″·6 and 290°·24. He also finds 89″·9 (mean of 4) for the distance of the second of Smyth's *comites.*

After a long interval we now return to finish the constellation *Cassiopea,* where several good objects are yet remaining for us.

110. *ψ Cassiopeæ.* 31″·9. 102°·1. 4½ and 9. Golden yellow and ash-coloured. The smaller star is again attended by a still more minute companion, 11 mag., discovered by W. Struve, with a distance of 3″·01, 1831·04, which Smyth mea-

sured 2″ and 252°·6, 1836·28. Secchi finds 2″·255 and 256°·45 as his means, 1858·822, both the little stars being white; and thinks it probable that the whole group may be physically connected and in perceptible motion. Should this indeed be so, how wonderful and glorious must such a spectacle be to an eye placed at a moderate distance, and how much more magnificent than any mere planetary combination! The object is an excellent test for a good telescope, especially as regards definition; but we must take a little pains in finding it. We have first to make out *κ Cassiopeæ*, 4 mag., which lies nearly *n* from *α* (see Int. Obs. VII. 57), and turns the triangle formed by *β*, *α*, and *γ* (the *p* side of the letter W) into a trapezium or irregularly-formed lozenge; then two lines run through *β* (the right-hand or leading star of the W in the diurnal motion) and *κ*, and through *α* and *γ*, will converge to a point somewhat beyond *ψ*. *ψ* also lies nearly *n* from *δ*, the fourth of the five principal stars.

If we run a line from our new acquaintance *κ Cassiopeæ* through *β*, and bend it a little to the *s*, or downwards (if we turn it a little upwards it will fall upon the wrong star, *ρ*, which is nearer *β*), we shall be guided at a little distance to—

111. *σ Cassiopeæ*. 3″. 323°·7. 6 and 8. Flushed white and smalt blue. Smyth calls this a miniature of *ε Boötis*, but with less fine colours. I made the companion tawny, 1850·71, but I have seen it blue this season with my present instrument. This illusion has been already referred to under Nos. 29, 62, 79, and 80 of the present list. Secchi finds little indication of motion. A low power exhibits this delicate and pretty object in a noble field, containing a second 6-mag. and several other considerable stars.

A line carried through *δ* and *ε* points nearly, at an equal distance, to—

112. 72 P. II. *Cassiopeæ* (*ι* of the catalogues of Dorpat and Rome). 2″·1. 274°·2. 4½ and 7. Pale yellow and lilac. A 9-mag. star of a fine blue tint stands at 7″·5 and 107°·1, making up a beautiful group. Dembowski gave the colours in 1854-1856, white, blue, and ruddy violet. The close pair forms an excellent test, requiring some amount of magnifying power. Secchi, combining Herschel I.'s measure, 290°·2, 1782, with his own, 265°·2, 1859·845, thinks an angular motion and a physical connection certain as to the close pair: the remote star seems unmoved.

In the galaxy, between *α Cygni* and *Cassiopea*, but rather nearer to the latter, the eye readily catches a triangle of 4-mag. stars, of which the base faces *Cygnus*. The apex is occupied by—

113. *δ Cephei*. 40″·9. 192°·2. 4½ and 7. Deep yellow and

cerulean blue. This is a magnificent wide object, almost equal to *β Cygni*, and one of the finest combinations of brightness and contrasted colour in the heavens. Common proper motion is suspected, and there are some indications of orbital revolution. The principal star is variable, and has the additional interest of being, according to Humboldt, the most perfectly regular in its returns of all these marvellous objects, since its discovery by Goodricke in 1784. The exact duration of its variation is given by Argelander at 5d. 8h. 47m. 39·5s. (Johnson however preferred 5d. 6h. 42m. 18·4s.), and its amount at about one magnitude or somewhat more, $3\frac{1}{2}$ being the *maximum*. Its increase and decrease are singularly unequal, being respectively 1d. 15h. and 3d. 18h.; but during 8h. of the latter period it scarcely changes, and very inconsiderably so for a whole day. We have hitherto touched very little upon this most curious branch of inquiry, which, at some future time, may well claim our attention. With a low power, *δ Cephei* lies in a beautiful field, comprising, among other stars, a very pretty little triangle at a short distance *n f*.

If we draw a line from *Polaris* to *α Cygni*, at about two-thirds of the distance, but somewhat bending out towards *Cassiopea*, we shall find a 3-mag. star, the brightest of the vicinity. This is *α Cephei*, or *Alderamin*. Between this star and *Polaris* lies a similar star, *β Cephei*. *γ Cephei*, of the same magnitude, the third and last of the leaders of this obscure constellation, is nearly equidistant from *β* and *Polaris*, but bends down towards *Cassiopea*. We must here imagine a rhombus, or lozenge, of which *Polaris* and *β* occupy the two acuter ends, while *γ* stands at one of the obtuse angles; then, near the opposite obtuse angle, but pushed as it were a little in and downwards from its correct position, lies our next object, the brightest of its immediate neighbourhood: it is—

114. *κ Cephei*. 7″·5. 123°·8. $4\frac{1}{2}$ and $8\frac{1}{2}$. Pale yellow and blue. W. Struve calls the large star greenish. Secchi thinks a very slow motion probable. This is a very beautiful pair, and in a fine low-power field.

About halfway between *β* and *δ Cephei* (No. 113), we find—

115. *ζ Cephei*. 5″·8. 288°·8. 5 and 7. Smyth called them both bluish, 1839·65: flushed and pale lilac, 1851·4. W. Struve found them yellowish and blue, 1831·77. I thought them white and tawny or ruddy, 1850·63. This very fine pair is stationary.

116. 232 with 230 P. XII. *Camelopardi*. 21″·8. 327°·3. 6 and $6\frac{1}{2}$. Bright white, with which the Dorpat catalogue agrees; but in 1852 I thought the colours of this superb pair a little dissimilar with my $3\frac{7}{10}$-inch glass, perhaps pale yellow and pale violet; and though the difference seems now but

trifling with $5\frac{1}{2}$ inches, they do not appear to be a perfect match. This object is said to be stationary; implying, of course, only that the measures have hitherto shown no appreciable motion; but its aspect is decidedly that of a connected system, and if so, as in many other cases, relative movement will be certainly detected in the course of time, for we have every reason to believe that gravitation is universal, and two adjacent bodies under its influence, unless kept asunder by rotation, must infallibly rush together to their mutual destruction. The pair will be found about 7° from *Polaris*, in a line drawn towards ϵ *Ursæ Majoris, Alioth*, the fifth star of that constellation, beginning with the *Pointers*: it is the first object at all evident to the naked eye in that direction from the Pole.

Between γ *Cephei* and ζ *Ursæ Majoris, Mizar*, the star which opened our present list, we find two conspicuous 3-mag. stars. These are β and γ in *Ursa Minor*, a constellation lying chiefly between them and the Pole. From γ, which is the further of the two from *Polaris*, we draw a line back to γ *Cephei;* then, rather nearer to γ *Ursæ Minoris*, and rather below this line, *i.e.*, further from the Pole, we make out a star which will repay all this trouble in finding it—

117. 40 *Draconis*. 19″·9. 235°·3. $5\frac{1}{2}$ and 6. Both white, 1839·81; and so W. Struve, 1832·95 (a mean of 3 years); but after $3\frac{7}{10}$ inches had shewed them to me white or yellowish, 1850·7, I noted them with the same glass, 1856·91, "both yellow; largest star deepest:" and I found them the same, 1863·13, with $5\frac{1}{2}$ inches; the hue of the smaller being perhaps not an exact *shade* of that of the larger star. A smaller lilac star at no great distance forms a beautiful group.

The little catalogue which is thus for the present concluded has no pretensions to completeness in any point of view. Its original intention comprised only such Binary and Double Stars, selected from the Bedford Catalogue, as would be both visible to the naked eye and capable of being identified by verbal description; omitting those which might be thought too close or too minute for ordinary instruments, or not sufficiently interesting for general study. Many, however, it need scarcely be said, of these excluded pairs, occupy debateable ground, especially at a time when superior optical means are daily becoming more accessible; as, on the other hand, not all of those which have been inserted may have appeared to some observers sufficiently worthy of notice. But, if our readers are not weary of the subject, it may be occasionally continued by the addition of objects requiring explanatory diagrams, or drawn from other sources of information, as well as by fresh remarks, from time to time, upon such of those already

enumerated as offer any distinct features of change. In the meantime enough, it is hoped, has been laid before the student to enable him to spend many an hour of tranquil enjoyment in the contemplation of these beautiful systems, and in the admiration of their Creator's power and glory.

PARALLAX OF MINUTE STARS.

In the preceding series of papers on Double Stars, attention has repeatedly been directed to a very remarkable point in the arrangement of the stars, the knowledge of which is essential to any accurate conception of the structure of the heavens. It was long and naturally supposed that the most conspicuous fixed stars were also the nearest, and that their brightness was, at least in a general sense, dependent upon their situation with respect to ourselves. It is now capable of demonstration that this is a fallacy. As far back as the year 1826, Sir John Herschel stated that there were "plausible grounds for a belief that, in situations remote from the Milky Way, minuteness, on the average, is not the effect of distance;" and this belief may now be said to have ripened into confidence. It may still be doubtful whether such an assertion may be applicable to the *average* of stars in any portion of the heavens; but it is no longer a question whether, in many instances, it may not be capable of direct proof. A fair presumption would arise from the admitted fact, that the proper motions by which many of the stars are steadily changing their positions are by no means always the largest in the brightest individuals; still, this presumption would not amount to actual demonstration. This could only be attained in one of two ways:—either by showing that great differences of magnitude exist between the components of binary systems (and it is this kind of proof to which reference has repeatedly been made in our Double Star list), or by the most direct mode of all—that of the detection of an annual parallax; in other words, an apparent change in the star's place resulting from an actual change in the position of the observer's eye, as our annual orbit carries us round the sun. It has been for some time known that the parallaxes of several of the brightest stars are, if not absolutely insensible, as Peters found with regard to *a* Cygni, and as Airey has suspected in the case of *a* Lyræ, yet much smaller than that of 61 Cygni, a star of only the 6th magnitude, which, according to Sir W. Herschel's estimate, would have been about twelve times more distant; but it has been reserved to the present day to carry onward this demonstration to a much greater extent by applying it to stars of a far inferior order. This interesting result has been obtained by means of the excellent heliometer at Bonn, in the hands of M. Krüger. A star of the

8·9 mag., No. 21,258 of Lalande's Catalogue, and another of the 9· mag., No. 17,415-6 in the Catalogue of Oeltzen, had been pointed out by Argelander as remarkable from their large amount of proper motion, in the latter case amounting to 1″·2 annually. Thirty-six comparisons of the former with two other suitably-placed stars yielded an amount of parallax = 0″·260, with a probable error of 0″·020. The latter star, from a mean of forty-five similar comparisons, showed a parallax = 0″·247, with a probable error of 0″·021. This, if confirmed by future measures, would bring these inconspicuous objects actually nearer to us than Polaris, Arcturus, or even the magnificent Sirius himself, and must suggest very remarkable speculations as to the probable structure of the Universe.

QUADRATURE OF VENUS.

During the present month, Venus will be an especially beautiful object, both in point of form and brilliancy. With a diameter gradually increasing from 19″·4 to 26″·8, the phasis will pass from a gibbous to a crescent shape, through the intermediate stage of *dichotomy*, or apparent bisection of the disc by a straight line, like the moon in her first quarter. This epoch falls by calculation on July 20th. It is, however, a curious fact, and one well deserving of attention, that the observed dichotomy, when the terminator, or boundary of day and night upon the planet's globe, is sensibly straight to the eye, has been repeatedly found not to occur when it should, at the time of the greatest elongation from the sun, but a little earlier or later, according to the position of the planet towards the east or west. This was discovered by Schröter in 1793, who found the terminator perceptibly concave at the greatest elongation, and thought it arose from the comparative faintness of the central part of the disc, as observed with high magnifiers, and on the bright background of a daylight sky, which might convey an illusory impression of concavity. Beer and Mädler not only re-observed it at both elongations in May and October, 1836, but confirmed it by the discovery that, both before and after the quadrature, the measured breadth of the phasis was less than that given by calculation. They attempt to account for this by a comparison with the moon, in which a similar aspect is produced, as they say, to the naked eye, especially by day, from the generally darkening effect of the shadows of the mountains towards the terminator. But this does not seem satisfactory. It may be questioned whether the lunar terminator is not as frequently thrown out by elevated ridges, as withdrawn by shadows; and, at any rate, such illusions with regard to the moon occur only by day, while the concavity of the terminator of Venus has been observed

on a background which would admit of no supposition of the kind, when every portion of her glittering disc has stood out in vivid relief against a darkened sky. It is somewhat singular that Beer and Mädler do not appear to have tested the value of their own supposition, as they might easily have done, by actual examination of the planet under these circumstances; when, it is but fair to suppose, they would have been led to doubt its sufficiency. Before I was acquainted with any of these observations, I had noticed the concavity of the terminator at the greatest elongation, 1833, March 6th, not only at sunset, but as late as 7h., and I also saw it in 1836, May 16th and 17th, one of their own epochs; unfortunately I have no record of the hour, but believe it was not during the day-time. According to their determination in 1836, the sensible dichotomy, or quadrature, takes place when the planet is six days further from the earth than at its computed quadrature—that is, six days before or after the greatest elongation as given in the Almanac, according to the direction in which the planet is moving. At the present epoch, if their data are correct, the apparent dichotomy will take place about July 14th. This will be an interesting point for amateurs, and quite within their reach, if the instrument shows Venus fairly with a sufficient magnifying power, as any good eye can judge very perfectly of the straightness of a line; a mean, also, may be found by taking careful sketches between what appear to be corresponding degrees of convexity and concavity on either side of the apparent dichotomy.

TRANSITS OF JUPITER'S SATELLITES.

These are now becoming rare.—July 14th, I. leaves the disc at 9h. 40m., the shadow remaining 1h. 16m. afterwards. 15th. III. enters at 9h. 30m., the shadow of II. being at that time upon the planet. 21st. I. enters at 9h. 23m. 30th. The shadow of I. goes off at 9h. 15m.

OCCULTATIONS.

Two occultations only happen at convenient hours.—July 28th. ξ^1 Sagittarii, 6 mag., will be hidden at Greenwich from 9h. till 10h. 7m. 30th. 8 Aquarii, 6 mag., from 8h. 29m. till 9h. 20m.

LITERARY NOTICES.

Among the various publications recently received, we may notice—

McLeod's Wall Maps. No. 3, Geological, by Edward Weller, F.R.G.S. *Longmans.*—This map belongs to an educational series, and by its size and clearness is well adapted for class teaching. The course of rivers, chains of hills, and boundaries of counties are purposely made very distinct, which is not the case in some geological maps, of greater merit so far as their one scientific object is concerned. We suppose the colouring of the Ordnance Maps has been departed from for the sake of allowing certain details of physical and political geography to appear more plain. The departure, however, involves the disadvantage that the student must learn the value of a new set of tints if he pursues the study any further. Those chosen by Mr. Weller must be admitted, however, to answer their purpose very well, if we except Nos. 12 and 9, which are too much alike to mark the broad distinction between the New Red Sandstone and the Coral Rag, etc., which they respectively signify in his scale. For geology, apart from other information, this map would not bear comparison with the smaller one by Professor Ramsay, but that would not answer the purpose of Mr. McLeod's series, as the division of the counties can scarcely be made out, and the printing of the names is generally indistinct, in both of which the present map deserves commendation.

A Systematic Handbook of Volumetric Analysis, by Francis Sutton, F.C.S., Professor of Practical Chemistry, Norwich. *Churchill.* This work is intended for the use of persons who are acquainted with the elementary principles and facts of chemistry, and wish to acquire the new and valuable art of Volumetric Analysis by the employment of *titrated* solutions. Solutions are thus named from the French, and signify their having a definite strength, or power, so that the action of precipitation or otherwise, exerted by a given quantity, is readily capable of arithmetical expression, and thus indicates the quantity of the substance acted upon. This method is much used in the best laboratories, and we believe Mr. Sutton has made the first successful attempt at giving a clear practical elucidation of the subject in the English language. His examples range over the principal articles which a private student or a manufacturing chemist would desire to analyse, and drawings are given of the apparatus required.

A Manual of Physiology for the Use of non-Medical Students, by John Shea, M.D. *Churchill.*—We regret we can only afford this book a qualified praise. In some respects it is well done and intelligible, but an uninstructed reader would be led to many erroneous conclusions. For example, after the researches of Balbiani, the function of the nucleus in infusoria can scarcely be called "quite uncertain," nor is it correct to say that "among the protozoa the mode of reproduction is limited to that of fission and gemmation." In speaking of the bryozoa, or polyzoa, as they are more commonly called, Dr. Shea merely observes that reproduction occurs in a manner similar to the process of budding in the hydra, and in the next

paragraph he speaks of the tunicata, and says that their multiplication either takes place by gemmation, "or by the more perfect method of development resulting from the meeting of sperm and germ cells." From this it would be inferred, contrary to fact, that neither the hydra nor the polyzoa exhibited in an elementary form the phenomena of sexual generation. The Edentata are spoken of as "quadrupeds wanting front cutting, or incisor teeth, their food being chiefly vegetable." As other animals show, there is no connection between the want of incisors and a vegetable diet. Moreover, some of the Edentata have no teeth at all, and many are insectivorous. It is in these natural history portions the most prominent defects lie of a well meant and, in some respects, useful book.

Liber Cantabrigiensis, Part II. An Account of the Changes made by Recent Legislation in the Colleges and University of Cambridge, with an Appendix containing the Examination Papers for the open Minor Scholarships in 1861-1862, by Robert Potts, M.A., Trinity College. *Parker.*—The title of this book sufficiently explains its object and contents. As an epitome of the way in which the Legislature has dealt with certain endowments to make them conform to the spirit of the age, the statement has a general interest beyond the class for whose benefit it has been specially compiled.

Experimental Essays, by Charles Tomlinson, Lecturer on Physical Science, King's College School, London. *Virtue Brothers.*—This excellent little book we have noticed before, in the article on the "Motions of Camphor," which appeared in our May number.

The Insect Hunter's Companion, by the Rev. Joseph Greene, M.A. *Van Voorst.*—Is a popular and readable guide to the collection of insects, pupa digging, etc.

A Few Words More about Gold, by Edmund Head Browne, of the Stock Exchange. *Groombridge.*—Is an important pamphlet on the gold question. Mr. Browne enjoys the credit of being one of the first to point out how the progress of industry would absorb the gold acquired from new diggings, and thus to a great extent neutralize the effect on prices which many economists were disposed to exaggerate.

Page's Introductory Text-Book to Physical Geography. *Blackwood.*—Is a very cheap and admirably devised work. The information is given in an agreeable, intelligible style. Hard words are avoided as far as possible, and when inevitable, their derivation and meaning are explained. It is one of the best books we know, whether for class teaching or private study.

The Flora of the West Riding: the Phanerogamous portion by L. C. Miall; the Cryptogens by B. Carrington, M.D. Ed., F.L.S., etc. *Pamplin.*—We cannot speak of this little book from any personal knowledge of its subject, but we understand that those who are competent to form an opinion consider it to be what it appears, a work of industry and merit. The information concern-

ing the locality of the various plants will be serviceable to collectors and those who study the distribution of the Flora of the British Isles.

Handbook of the British Flora, by George Bentham, F.R.S., President of the Linnæan Society; with Engravings from original Drawings, by W. Fitch. Part I. *Lovell Reeve & Co.*—This new botanical work is intended, as the title-page informs us, "for the use of beginners and amateurs." Mr. Bentham's name leaves no doubt concerning its scientific value, and the information is conveyed in a much simpler and more intelligible style than botanists often think proper to employ. The descriptions will be readily understood if the student has "Henslow's Dictionary of Botanical Terms" to refer to: and the engravings, which are very numerous, are carefully executed.

Profitable Gardening, by Shirley Hibberd, F.R.H.S. *Groombridge and Sons.*—In the space of a small, elegantly-printed volume, Mr. Hibberd has condensed the results of his well-known skill and experience, so as to offer to the public "a practical guide to the culture of vegetables, fruits, and other useful outdoor garden products." Thousands of families will rejoice in good vegetables through these admirable directions how to grow them. Few men know as much of their subject as Mr. Hibberd, and still fewer can impart such knowledge in so pleasant a way. The book is full of valuable observations, and as it is a matter of national importance, we recommend every cultivator of potatoes to note what Mr. Hibberd has to say with reference to avoiding the disease.

A Popular Treatise on Photography, translated from the French of D. von Monckhoven by W. H. Thornthwaite. *Virtue Brothers and Co.*—The clearness of the descriptions, the multiplicity of the illustrations, and the cheapness of this work commend it strongly to the attention of beginners in a delightful art.

London Scenes and London People: Anecdotes, Reminiscences, and Sketches of Places, Personages, Events, Customs, and Curiosities of London City, Past and Present, by Aleph. *Collingridge.*—A very elegant volume, the subject of which is sufficiently indicated by its title. We have read it with much pleasure, and shall hope that the subject will be continued, as many points of interest remain untouched, and the march of change—not always improvement—is rapidly destroying monuments of national as well as local interest. The illustrations are beautifully executed, and must give permanent value to the work. We ought to add that the papers are reprinted from the *City Press*, to whose popularity they contributed in no slight degree. They are good specimens of their class of writing, graphic and lively.

PROCEEDINGS OF LEARNED SOCIETIES.

BY J. W. TERGEMEIER.

CHEMICAL SOCIETY.—*May* 22.

On the Effect of Intense Heat on Liquids.—The paper by Mr. Grove, which was announced under the above title, excited much interest among the members of the society. Mr. Grove first called attention to the difference existing between the boiling of water under ordinary circumstances, and that of sulphuric acid. He stated that the equable evolution of steam, when water is boiled in an open vessel, is caused by the presence of a certain amount of air dissolved in the water, and that boiling may be regarded as an evaporation into the liberated bubble of air set free by the elevated temperature. In an open vessel a sufficient amount of air is continually reabsorbed, so that the ebullition goes on equally. On the contrary, when water is heated in a very long tube, it boils in the first instance evenly, but after the air is expelled it boils with the most violent concussions; during the regularly recurring intervals between the sudden and violent emissions of steam, the temperature rises far above 212°, and then a sudden explosive production of steam occurs, almost resembling the discharge of gunpowder.

By placing a portion of water in a flask under the vacuum of a good air pump, and heating it by the transmission of a strong electric current, passed through a fine platinum wire contained in the water, Mr. Grove proved that the water did not boil at all, but that the whole burst up into violent concussions at regularly recurring intervals.

Mr. Grove suggested that the phenomena of the Geysers, or intermittent explosive fountains of Iceland, would admit of a more satisfactory explanation by reference to these facts, than on the supposition of the existence of complicated subterranean chambers.

In the course of his experiments Mr. Grove ascertained that it was almost impossible to free water from gaseous bodies, and that the steam liberated from this liquid when boiled under oil, always leaves a small bubble of permanent gas; when condensed, this gas was found to consist of nitrogen.

These views of Mr. Grove's appear equally interesting in a practical, as in a strictly scientific point of view. It has been already suggested by Mr. Church that the violent and dangerous concussion arising during the distillation of sulphuric acid in glass retorts, may possibly be prevented by the passing a small stream of finely divided air through the boiling liquid. And it appears to the writer that many of the mysterious explosions that occur in steam-engine boilers, and which have hitherto never been satisfactorily explained, may be due to the expulsion of air by long-continued boiling, and the explosive liberation of steam as a consequence.

The report of this highly valuable paper of Mr. Grove's is not

as complete as might be wished. But in the pestilential atmosphere existing in the upper part of the meeting-room of the Chemical Society, it is almost impossible to follow the course of an argument. The Chemical Society has the pre-eminence of meeting in the worst ventilated room in London.

ROYAL INSTITUTION.—*June* 12.

Preparation of Magnesium.—At the evening meeting of the members of the Royal Institution Mr. Tegetmeier exhibited a mass of magnesium which had been prepared by Mr. E. Sonstadt, who has recently patented a process whereby this metal may be obtained in quantity.

Mr. Faraday called the attention of the members to the remarkable properties of this metal. Its whiteness, resembling that of silver, and high metallic brilliancy, were shown by means of the electric lamp. A wire of the metal was ignited in the flame of a candle, when it burnt with a white light of such dazzling intensity as totally to obscure the ordinary illuminating agents, such as gas and candles, and to rival the brilliancy of the electric light. Mr. Faraday stated that notwithstanding its strong attraction for oxygen, it was preserved from change, when in a mass, by the thin film of oxide covering and protecting the exterior surface from the exposure of the air.

Mr. Sonstadt's process for preparing magnesium on a manufacturing scale consists in decomposing a mixture of fused chlorides of magnesium and sodium by means of metallic sodium, and in the employment of iron vessels to effect the decomposition. It is found that the magnesium acts on the slica of earthenware crucibles, decomposing it, and uniting with the silicom; nor can platinum crucibles be employed, as the magnesium alloys with that metal, causing it to become fusible at a moderate temperature. The chloride of magnesium employed is best obtained from the mother liquor, left after evaporating sea water for its salt. Mr. Faraday stated that as every ton of sea-water contained above two pounds of magnesium in the form of chloride, the entire ocean would contain 160,000 cubic miles of magnesium. This would form a solid block fifty-four miles cube.

The specific gravity of magnesium is 1·75, resembling in its lightness the analogous metal alluminum. Now that magnesium is capable of being obtained quickly, there is no doubt that important applications of its singular properties will present themselves. The metallic bases of the earths are in so much greater abundance than the ordinary metals, that any attempt to isolate them for economic and practical purposes must be regarded with great interest, as bearing strongly on the advance of not only the scientific arts, but also of those having reference to daily life and advancing civilization.

UNIVERSITY COLLEGE.—*June* 10.

The Ordeal Bean of Calabar.—At the conversazione held at University College on the 10th of June, Professor Harley exhibited

specimens of the bean employed by the King of Calabar as a poisonous ordeal to determine the guilt or innocence of accused persons.

The plant yielding this bean is kept secret from the natives generally, and the seeds are consequently to be obtained only with great difficulty. The name that has been given to the plant is *Physostigma venenosum*, or *Calabar ordeal bean*. It belongs to the Leguminous tribe, having distinct papilionaceous flowers, succeeded by pods about six inches in length, each containing four or five seeds, having white cotyledons, resembling in taste the seeds of the common haricot, *Phaseolus vulgaris*. The leaves are ternate.

Taken internally the beans, unless rejected by vomiting, produce fatal paralysis. In some experiments made in this country it has been found that twelve grains have produced partial paralysis, threatening to be serious in its results. In the course of investigation into its properties, it has been ascertained that the extract of the bean possesses a most extraordinary power over the iris, a few minims of its solution dropped into the eye causing contraction of the pupil to such an extent that the aperture becomes entirely obliterated, and the eye possesses the appearance of having an imperforate iris. In order to demonstrate this action more fully, and to contrast it with the opposite effect of a solution of belladonna, a cat was exhibited, to one eye of which belladonna had been applied several days previously, causing dilatation of the pupil to such an extent that the iris was scarcely visible; to the other eye a solution of the ordeal bean had been applied, which caused obliteration of the pupil. The contrast between the two eyes of the animal was of the most marked character, and imparted a strange weird expression to the face. In the course of the evening the pupil dilated somewhat—the effect of the Physostigma passing away gradually in the course of about twenty-four hours, whereas that of the belladonna persists for many days. Specimens of the plant have been raised in this country from the imported seeds.

GEOLOGICAL SOCIETY.—*June* 3.

On the Section at Moulin-Quignon, and on the peculiar character of some of the Flint Implements found there. By J. Prestwich, Esq., F.R.S., F.G.S.—The recent discovery of a human jaw and of flint implements of a peculiar type and fresh appearance at Moulin-Quignon has led to questions having been lately raised as to the age of the gravel-beds, and the antiquity of these remains. Mr. Prestwich showed how conflicting had been the evidence in support of the views formerly entertained, and gave a *résumé* of the proceedings of the Conference lately held at Paris and Abbeville, and remarked that the intrinsic evidence appeared to prove the spurious nature of the objects, while the evidence derived from the study of the beds had led to the opposite conclusion. The author then showed that, from the physical configuration of the district, corroborated by the presence of extinct mammalia distinctly of contemporaneous age, the modern age assigned to these beds by some geologists could not be maintained, and that, from the occurrence

of freshwater shells in both the high and low-level gravels, their formation must have been due to river-action, and not to a wave of translation or other modification of marine action. Mr. Prestwich concluded by stating that, whatever may be the conclusions drawn from the jaw and the flint implements, the age of the deposits is to him perfectly well determined as being of the early quaternary or post-pliocene period, older than the Menchecourt gravels, and anterior to the excavation of the valley of the Somme; and as some flint implements, the genuineness of which is not doubted, have been found in these deposits, the question of the antiquity of man will not be affected, whatever the conclusions arrived at with regard to certain others.

ROYAL GEOGRAPHICAL SOCIETY.—*June* 10.

African Explorations.—The President announced the return of Captains Speke and Grant from their successful expedition to trace the source of the Nile, and read the following letter containing intelligence from Madame Tinné and her daughter, who had proceeded in their steamer on the Bahr-el-Ghazal, the western affluent of the White Nile:—

"21*st March*, 1863.

"Here we are, come to a stop again; that is, as far as we can go in the steamer on the Bahr-el-Ghazal. We are near to an island which Petherick calls Kyt, but the natives call it 'Misr of Reg.' Its longitude is 26° 45′ East of Greenwich." [This may probably be depended upon, as Mr. Von Heuglin and his companion, both scientific men, are of the party.] "The Bahr-el-Ghazal is more like a very narrow canal. There is little to say of it. It winds through high grass and bulrushes, large plains with huts and flocks at a distance, and nothing else. This is a very difficult place to come to, as the river, though deep, is choked with rushes and a soft-wooded sort of tree, which breaks as our ships pass, but is very formidable to look at. The leaf is the same eternal mimosa-shaped leaf, and it bears a large yellow flower like broom, and very sweet scented. We came through it with the steamer, having the paddles taken off. Our learned friends have found sixty curious new birds and an unknown fish, as well as several new flowers and plants. Mr. Von Heuglin and the Doctor have made some valuable observations. No one the least scientific seems ever to have been here before us."

BRISTOL NATURALISTS' SOCIETY.

The first annual meeting of this Society was held on May 8th. The report disclosed highly satisfactory progress during the past year. Mr. W. Sanders, F.G.S., observed that a society of this kind ought to work out completely the natural history of the neighbourhood, and therefore it was desirable to notice matters of seemingly trivial import, as the habitat of rare plants and insects, the order of the geological strata, occurrence of fossils, the time of arrival and departure of migratory birds, the occurrence of rare species, etc.

Every member might aid in this, and communicate his observations, however trifling, to some member of the committee, for registration.

The following gentlemen were elected as the committee for the ensuing year:—Officers of the Society: *President*, Mr. W. Sanders. *Vice Presidents*, Dr. Alfred Day, LL.D., and Rev. Canon Guthrie. *Hon. Secretaries*, Mr. A. Leipner and Mr. W. L. Carpenter. *Hon. Treasurer*, Mr. W. W. Stoddart. Dr. Beddoe, Dr. Martin, Dr. W. Bird Herapath, Dr. H. Tripp, Mr. Hugh Owen, and Mr. W. J. Fedden.

At the January and April meetings of the Society a very elaborate paper was read by Dr. Day, entitled, "An Account of the Methods used by Mr. Bunt in Investigating and Predicting the Tides of the Port of Bristol." After speaking of the action of the sun and moon, and the greater effect produced by the latter in consequence of her proximity, he remarked that every one of the numerous lunar variations had more or less effect on her tide, and the effect was complicated by the inclination of her orbit to the ecliptic: hence the subject was beset with very great difficulties, and accuracy of prediction could only be obtained by a lengthened series of close observations, and the classification of these according to some theory. Mr. Whewell having pointed this out, Mr. Stutchbury (then curator of the Bristol Institution) selected Mr. Bunt as the gentleman best qualified for the task. The author here paid an eloquent tribute to the talent, conscientiousness, and exactness of Mr. Bunt, showing how admirably he was fitted for the post, and read extracts from a long correspondence that took place between Mr. Bunt and Mr. Whewell, which was, he said, honourable alike to both in the highest degree, and he then proceeded to explain a model of Bunt's tide gauge, which had been in constant operation for twenty years, recording upwards of 14,000 tides. It consisted essentially of a float on the surface of the water in a wooden trunk inserted in the river, which float was counterpoised by a weight, attached to the other end of a cord, passing over a large wheel, on the prolonged axis of which was an eccentric with a pencil. This pencil, moved thus in a vertical direction, was pressed by a lever against a vertical cylinder, covered with paper, and kept revolving on its axis by machinery driven by an accurate clock. The effect of the two motions combined was to trace a curve on the paper, from which the height of the tide at any given moment might be readily determined. After a great number of these had been obtained, the first thing was to obtain from them a mean curve, called the normal, or semi-menual curve, of high waters. This was then projected into a horizontal line, and the intervals between the curves of observation and the normal measured upon it, and the results compared with the known declination and parallax of the sun and moon. From these data, correction tables were made, both for parallax and declination of the sun and moon, and Mr. Bunt believed that these could not be improved, as further observation and taking of means gave no better result. There were several other smaller corrections to make, but at the present time the result of twenty years' observations had been so systematised

that the actual prediction of the time and height of any future tide was obtained by shifting one curve, on transparent paper, over another, according to the desired date, reading off figures as in a "patent abacus," and adding the hours, minutes, etc., thus obtained to the time of the moon's meridian passage for that day, as given in the *Nautical Almanac*. When the actual results were compared with the predictions, the average error in time was only about one minute, the errors being greatest at neap-tide; the errors in height were greater, owing to the wind increasing or diminishing the height of a tide. Many curious facts were mentioned, as that the height of the tide varied with the height of the barometer, rising fourteen inches with a rise of one inch in the mercury; that the average velocity of the spring-tides was thrice that of the neap; that the height was greater at the mouth of the Avon, where also the mean sea-level was higher than round the coast of England; that the tide may rise in the first hour and a quarter as much as it falls in three hours and a half; that the highest possible rise of tide in the Avon, except with the aid of wind, was thirty-three feet; that at different places there was a different relation between the forces of the sun and moon, etc. Dr. Day concluded his paper by pointing out that these predictions, so successful, were entirely tentative, being, in fact, the results of five tentative processes.

At the January meeting, also, Dr. W. Bird Herapath made a verbal communication on the presence of arsenic and thallium in the medicinal preparations of bismuth, the former of which impurities might be removed on a manufacturing scale by boiling the bismuth with caustic soda; the quantity of arsenic varied, he said, from 1 in 433 to 1 in 1000.

At the February meeting, the President announced the discovery of the scales of the Holoptychius, one of the ganoid fishes allied to the Cephalaspis, in the beds of Old Red Sandstone at Portishead, at a depth of 600 or 700 feet below the mountain limestone. Hitherto no fossils had been found in these beds, and this discovery showed that they belonged to the upper of the three divisions of Old Red Sandstone.

Mr. C. B. Dunn then read a paper on "The Cotton Plant: its Nature, Cultivation, and Use."

Mr. Hugh Owen read a paper entitled, "Great Departure from established Types not always sufficient Reason for specific or generic Distinction among the Mollusca," giving numerous examples (illustrated by specimens) of shells, with distinct generic or specific names, where they were really only earlier stages in the growth of the animal, or forms modified by accidental circumstances of climate, food, etc., as was proved in many instances by the exhibition of a graduated series, showing one form imperceptibly passing into the other, and he stated that some of the species makers were in the habit of destroying these intermediate terms of the series, so as to render the difference between the extremes well marked.

The March meeting of the Society was occupied with a very elaborate and interesting paper from Mr. W. W. Stoddart on Fossil Otoliths, and the auditory organs of the lower animals.

We abstain from reporting this paper, as we understand that Mr. Stoddart, after some further researches, intends to write a memoir on the subject himself.*

At the annual meeting in May, it was agreed that the months of June, July, and August should be devoted to excursion meetings, similar to those held last year.

W. Lant Carpenter, Secretary.

NOTES AND MEMORANDA.

Effects of the Calabar Bean on the Eye.—Mr. H. Carter Wigg communicates the following interesting facts:—"Before the discovery of the powers of this bean, by Dr. T. Fraser, a few months ago, no agent for the contraction of the pupil was at our command. Its action on the eye is singular and valuable; shortly after its introduction, as an extract or solution, there is some pain in the parts connected with the pupil, and gradual contraction of it till it becomes the size of a pin's point. It has even, as Mr. Soelberg Wells states, the power of causing contraction of the pupil when applied after the head is cut off. When 1-20th drop was placed in the eye of the writer, it induced marked contraction in less than two hours. It is produced from a leguminous plant of great size, the *Physostigma venenosum* (sub-ord. Papilionaceæ), with long thin stems. As a poison it is most powerful. In an experiment performed by Professor Harley, of University College, a fragment the size of a millet seed was used to poison two animals (a cat and a rabbit) successively, and on being removed from the body of the second, still retained sufficient strength to contract the pupils of another animal." For some additional particulars, see page 461.

Function of the Contractile Vesicle in Rhizopods.—Dr. Wallich, in the third paper in the *Annals of Natural History*, on the Amœba villosa, confirms the statement of Carter, that in rhizopods the contractile vesicle invariably discharges itself externally, and he says it does so through an orifice which is not of a permanent nature.

The Species Difficulty.—Dr. J. E. Gray states, in *Annals of Natural History*, that he finds "two very distinct forms of *Anthriscus silvestris*" growing side by side on the banks of the Thames, between Kew and Richmond—one is a large succulent plant, of a bright, rather palish green colour, much branched, and with large broad leaves; the stem is thick, and has a few large ridges, and the flowers are rather large; the other is a slender, rigid-stemmed plant, with comparatively few and distant branches, and comparatively few and smaller leaves; the stem has many small unequal ridges; the stem and foliage are always dark. He remarks that these differences cannot arise from soil, situation, etc., as they grow side by side, and flower at the same time.

Observations on Mars.—The *Proceedings of the Royal Society*, No. 55, contains a paper with drawings of Mars, by Professor Phillips. He regards the "broad white, or rather reddish band, which, from about 65° N. L., spreads up into large, cloud-like prominences towards and beyond the equator, and retires into one of the principal and several smaller bays towards the pole," as one of the main features very firmly defined in the last opposition. On comparing the sketches of Professor Phillips and Mr. Lockyer, it was found that the differences principally affect the gray southern parts, and are remarkable enough to justify serious doubts whether any of our drawings of those parts are much to be trusted as representing permanent physical boundaries. Mr. Phillips adds that this is not surprising, as the "enormous transfer of moisture from one hemisphere to the other, while the snows are melting round one pole and growing round the other, must generate over a great part of the planet heavy storms and great breadths of fluctuating clouds, which would not, as on the quickly rotating mass of Jupiter,

* The paper will be found in our present number.

gather into equatorial bands, but be more under the influence of prominent land and irregular tracks of ocean."

The Eclipse of the Moon, June 1st.—The total eclipse of our satellite was beautifully seen in London, although in some districts, if not in all, a fog-coloured cloud took off the sharpness of the commencing shadow. Both in London and Paris a greater quantity of light was noticeable at the upper part of the moon, which was nearer than the lower part to the limit of the earth's shadow. The entire disk was seen at the height of the eclipse, and different portions exhibited varieties of tint as well as of luminosity. M. Flammarion commenting in *Cosmos* on this visibility of the disk, considers the best explanation to be that of Arago, which has not met with general acceptance; namely, that in consequence of the irregular refractive power exercised by the earth's atmosphere, certain portions of sun-light are bent out of their course and fall upon the moon within the calculated dimensions of the cone of shadow. He considers it cannot arise from a light proper to the moon herself, as the annals of astronomy tell of many instances in which her disk was completely hidden by the eclipse, especially in that on 25th April, 1642, described by Hevelius. As the moon was obscured on the 1st ult., stars, previously lost in her light, began to appear, and small ones seen through the telescope were beautifully bright. In Paris it was remarked that the copper-red tint usually observed was exceedingly faint. In London it was sufficiently noticeable to have a very solemn effect.

Secretion of Urea and Chloride of Sodium.—Dr. Emil Becher, assistant-surgeon army medical staff, took advantage of a voyage to China to make a series of observations on the relation between air temperature and the secretions above mentioned, as carried on in his own person. He found a constant increase of the secretions with the rising temperature from 50° to 70°, and an equally constant falling off, with the further rise of temperature from 70° to 90°.—From *Proceedings of the Royal Society.*

Change of Form in Metals by Irregular Cooling.—Lieutenant-Colonel H. Clerk has communicated to the Royal Society some curious experiments on this subject. It appears that a wheel had to be shoed with a hoop tire, which was required to have a bevel of about $\frac{3}{8}$ths of an inch, and one of the workmen suggested that this could be accomplished by heating the tire red-hot, and immersing one half its depth in cold water. This was done, with the predicted result, the part out of the water being reduced in diameter. A series of experiments followed, with similarity of action, the cylinders always exhibiting a contraction above the water line, followed, if they were sufficiently high out of the water, by an expansion corresponding to that below the fluid. The explanation given is, that the parts under the water cooled quickly, and those above it slowly. If no cohesion had united the two parts, both would have obtained the same diameter, one first, and the other afterwards; but as the cohesive power of cast-iron, or other metal, is great, the under part tends to pull in the upper, and the upper to pull out the under. In this contest the cooler metal, being the stronger, prevails, and so the upper part gets pulled in, a little above the water-line, while still hot. But it has still to contract in cooling, and this it will do to the full extent due to its temperature, except so far as it may be prevented by its connection with the rest.—*Proceedings of the Royal Society.* The name of the workman who made this fundamental discovery ought to have been mentioned with due honour. He is a more important person in the transaction than Lieutenant-Colonel Clerk, who has taken care to secure the credit of what he has done in it. Science knows nothing of social vanities; the best observer stands the highest, whatever his rank.

Functions of the Liver.—The *Proceedings of the Royal Society*, No. 55, contain an important paper on "The Amyloid Substance of the Liver, and its ultimate destination in the Animal Economy," by Robert McDonnel, M.D. The author concurs generally in the views of Dr. Pavy, but with respect to the destination of the amyloid substance he considers that it is on its way upward, and that the process of healthy assimilation tends to promote it from the rank of ternary or hydro-carbonous bodies to that of quaternary or nitrogenous substances, and that its conversion into sugar is to be looked upon as a deviation from this

progressive course. From his own observations, and the statements of Brown-Léquard, Lehmann, and others, he views the liver as "a great blood-making organ, in which there is constantly going on a reconstruction of certain ingredients of the blood: that in it the fibrine, etc., which has done its work, is disintegrated, the hydro-carbons of the bile abstracted, and the nitrogen combined with the amyloid substance, which, instead of being normally changed into sugar, emerges from the liver, a constituent principle of the proto-plasma, from the bosom of which—to use the words of Bernard with reference to fœtal tissues—organic evolution is to be accomplished."

The Numidian Crane in the Orkneys.—Mr. William Reid, of Kirkwall, informs us that a pair of the above birds (also called the "Demoiselle") have been seen, and a male specimen shot at Deerness. The gulls and lapwings continually attacked the two strangers, which uttered a hoarse scream when pursued. The specimen which was shot was in good condition, but no aquatic animals, which constitute its usual food, were found in its stomach—only oats.

An Earthy Rain.—On the 1st May a rain fell at Perpignan bringing down with it a red substance, which proved, on examination, to be a red meal mixed with fine sand. Similar substances fell on the same day at various points on the shores of the Mediterranean. At Perpignan there was a violent storm, accompanied by thunder.

Maize Paper.—A writer in *Cosmos* states the paper used for the books printed for the primary schools in Austria is composed of the cellulose of maize, and has a yellowish tint, less fatiguing to the eye than the dead white of ordinary rag paper.

Peculiarities of Smell.—The insensibility of certain eyes to particular colours, and of certain ears to particular sounds, appear to have their counterpart in the insensibility of certain noses to particular odours. Thus a gentleman, who is fond of sweet-scented flowers, informs us that he does not recognize the peculiar odour of the syringa, although roses, violets, mignonnette, etc., produce their normal effect on his olfactory nerves. This singular fact suggests an interesting train of inquiry which we believe has been hitherto neglected.

Vessels of Plants.—M. Lestiboudois publishes in *Comptes Rendus* researches on the vessels which hold the coloured juices of plants. In the stipules of the *Ficus elastica* he says they are easily seen on removal of the epidermis. Coagulating the fluids by plunging the leaves into boiling water demonstrates the presence of true vessels in more difficult cases.

Ruby-Copper.—Some very beautiful groups of arbical crystals of ruby-copper—the suboxide of that metal, $Cu_2 O$, and known to mineralogists as *Cuprite*, have been lately found upon the porous cells of a Daniell's battery which had been long in use. They occurred upon the electrolytically-deposited copper, singly and in masses. Though visible to the naked eye, the beauty of their appearance was greatly enhanced when they were viewed under the microscope with a low power and a brilliant light. It would seem that cuprite is frequently deposited with electrotype copper, and that when copper of this kind is melted, the cuprite partly dissolves in the metal, lowering its conducting power for electricity. Specimens of such copper, indeed, do not yield on analysis their full percentage of metal, and the presence of silicon, phosphorus, or of other elements which reduce conducting power, has been therefore suspected in them. The phenomenon above referred to may help to explain the anomaly.

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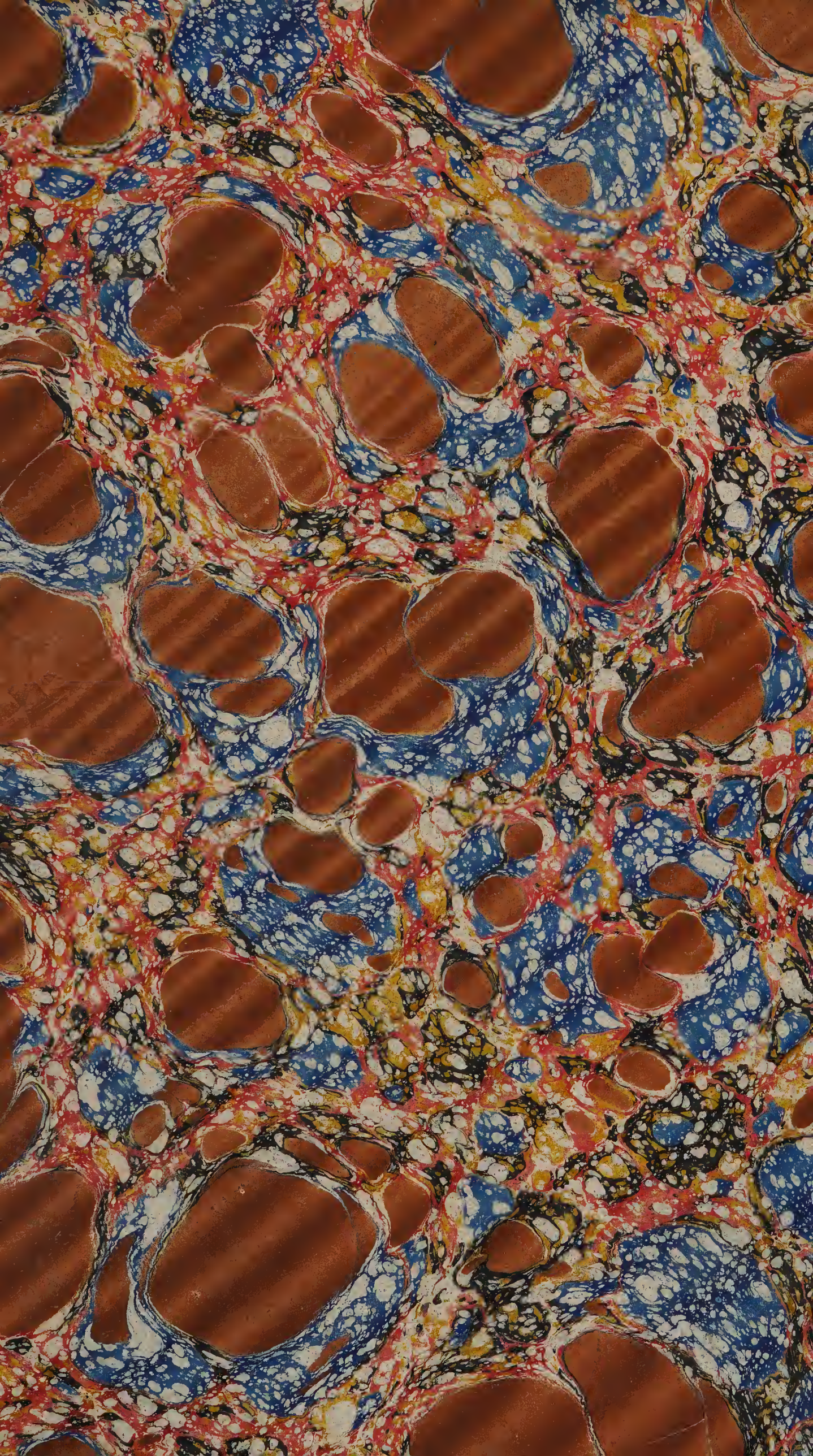
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